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ABSTRACT

Objectives and results are given of a program designed to prepare women for employment in engineering at a level comparable to current B.S. graduates. The program endeavored to create a learning situation in which rigorous academic standards would be maintained, while at the same time taking into account the realities of the lives of re-entry women. The format allowed women to work full-time while having an intensive review of mathematics and physics, followed by a series of 7 engineering courses. Most of the original objectives were achieved. (MP)

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WOMEN IN ENGINEERING

UNIVERSITY EXTENSION of California, Davis

1976-1978 NATIONAL SCIENCE FOUNDATION WOMEN IN ENGINEERING PROGRAM
FINAL REPORT

SE 028 627

CN001867

University of California Extension - Davis

F I N A L R E P O R T

on

NATIONAL SCIENCE FOUNDATION "WOMEN IN ENGINEERING PROGRAM"

July 1, 1976 - July 8, 1978

Submitted by:

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Any opinions, findings, and conclusions or recommendations expressed in this publication are those of the authors and do not necessarily reflect the views of the National Science Foundation.

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I. INTRODUCTION

The NSF Women in Engineering Program was designed in response to the call for proposals for the National Science Foundation's new Career Facilitation Project. The Dean of Extended Learning (himself an engineer), called together an Extension specialist, versed in creating effective educational programs for adults, and a woman who had considerable experience in creating programs for women in engineering.

Their proposal focused on engineering because that was their common area of expertise and it coincided with a strong national demand for more qualified engineers. The team endeavored to create a learning situation in which rigorous academic standards would be maintained, while at the same time taking into account the realities of the lives of re-entry women.

What resulted was a unique format which allowed women to work full-time while having an intensive review of math and physics, followed by a series of seven engineering courses. Accompanying the academic program were professional and personal support activities.

The details of the program, its objectives and results, is contained in this report.

II. PROGRAM OBJECTIVES AND HOW WELL THEY WERE ACHIEVED

The following are the objectives which were stated in the original grant proposal dated April 8, 1976. Next to each is a brief statement of how well that objective has been fulfilled. Additional detail will be found in the text of the report.

A. "To locate women with B.S. degrees in mathematics, physics, chemistry, computer science, and engineering who are currently unemployed or underemployed."

By use of direct mailings, newspaper advertisements, press releases, and items in alumni and Extension mailings, the program was able to reach this target group. Eighty-six persons completed applications; 58 were accepted; 40 participated in the initial summer session; and 28 received Certificates of Completion. The largest number of participants held degrees in mathematics. Most had been employed during the year prior to the beginning of the program. Many had been teachers. Several men applied for the program and one was accepted. A surprising occurrence was the large number of applications from people with degrees from other countries, especially the Philippines.

B. "To offer these women the opportunity to enroll in an educational program designed to give them competitive skills equivalent to entry-level B.S. engineers in industry or graduate school."

Fifty-eight persons were offered the chance to participate in the special program of courses designed for this project. The curriculum was altered from that which was originally outlined in the grant proposal. It was made more focused in an effort to emphasize marketable skills, and since few applicants requested the mechanical engineering option, only electrical engineering was offered.

C. "To design a program of study which will make participants eligible for

employment as engineers at the B.S. level."

The final curriculum which was actually offered contained a core of three fundamental engineering courses (Circuits; Statics; and Properties of Materials), followed by three more specialized electrical engineering courses (Electronic Circuits; Linear Systems Analysis; and Computer Structure and Microprocessors). The program culminated in a design-oriented Instrumentation Systems course. The Microprocessor and Instrumentation courses made the program's graduates extremely attractive to employers of electronics engineers and resulted in their being offered positions which were at least equivalent to those offered to B.S.E.E. degree holders.

D. "To provide participants with the background needed to compete successfully in graduate programs in engineering."

Because this was not stated as a primary objective in our recruiting literature, very few people entered the program with the intention of attending graduate school full-time upon completion of the Women in Engineering Program. Two participants applied for graduate programs in engineering (one at University of California, Davis, and one at Stanford) and both were accepted. It is too early to tell how successful they will be in graduate school. One of the participants has also applied to a graduate program in psychology. A number of the women expect to attend graduate school on a part-time basis in the next few years.

E. "To provide this education in a format which will accommodate the employment and family responsibilities of women who have been out of college from two to fifteen years."

The program format was specifically designed to fit in with the demands on women who (a) were working full-time and/or (b) had family responsibilities. The summer sessions were limited to two weeks in length so that women could attend during their regular vacation and would not need

to take additional time away from work. Aside from the summer sessions, all classes were held on weekends, so that participants could work full-time during the week. No evening classes or meetings were conducted during the week so that the women could spend time with their families. It was assumed that on the weekends, the women's husbands would be able to take over child-care responsibilities if there were young children in the family. Courses were taught in a convenient central location (Berkeley) so that essentially no one needed to relocate in order to participate in the program. Participants were able to commute on weekends and did not have to disrupt their family and employment arrangements.

F. "To enroll 20 to 40 students in the program."

Fifty-eight persons were accepted into the program; 40 began in 1977; and 28 completed the program. Given that the grant from the National Science Foundation amounted to $64,531.00, the cost per person who entered the program would be $1,613.28 per person; the cost per person who completed the program would be $2,304.68.

G. "To retain at least 80% of the students through to the completion of the program."

Twenty-eight of the original participants received Certificates of Completion. This amounts to 70%. A large portion of the group who did not complete the program had received their degrees from other countries. Several others secured full-time regular engineering employment during the year and did not continue the program.

H. "To provide a review of mathematics, physics, and computer programming sufficient to allow participants to succeed in the engineering instruction portion of the program."

The initial summer session at UC Davis gave students 32 hours of review in mathematics through differential equations; 15 hours of review in

physics; and 10 hours of introduction to Fortran programming. Another 22 hours of engineering mathematics instruction completed the math review. For most of the participants these reviews were sufficient to enable them to succeed in the later engineering courses.

I. "To assist students with job placement."

During the fall semester the students attended a seminar on resume writing and one on interviewing techniques. They were encouraged to submit resumes for the program's "Placement Brochure" which was mailed to over 500 engineering employers. Throughout the year, the women were given names of professional recruiting firms and many of the students got excellent contacts through these organizations. The optional CO-OP program was also exceedingly helpful in facilitating permanent job placement.

J. "To evaluate the structural components of this process as a model for other re-entry programs involving women, especially women in science."

The format of the NSF Women in Engineering Program has proven to be successful in attracting and retaining a large number of well-qualified participants. While it is very demanding, students say they like the intensive two-week review in the summer and they like having classes taught on weekends instead of during the week. This arrangement has allowed for participation by women who need to work full-time to help support their families. The series of seven increasingly specialized electrical engineering courses worked well. The personal and professional support activities turned out to be an important element in the program's success. The unique format of the program could well serve as a model for other women's re-entry programs.

K. "To disseminate the results of the program evaluation to educators in the western region of the United States."

A formal presentation of the program's results is scheduled to be made by Donna Frohreich at the winter 1979 College-Industry-Education Conference of the American Society for Engineering Education and will be published in the proceedings of that meeting. The program evaluation will be distributed to interested persons who are part of the Women's Educational Equity Network, headquartered at Mills College in Oakland, California. Engineering colleges, the Society of Women Engineers, and various foundations will also receive copies of the report.

III. PROGRAM ELEMENTS

III. A. Academic Portion of the Program

This section will include data on: 1. Academic Objectives; 2. Curriculum, credit, instructors, dates of courses; 3. Grades earned in each course; 4. Course outlines and texts used; 5. Comments.

1. Academic Objectives

The primary objective of the academic portion of the program was to give students the engineering knowledge necessary to make them eligible for entry-level positions as electrical engineers. A secondary object was to prepare them to succeed in graduate programs in engineering, i.e. to give them the engineering fundamentals necessary for further graduate study.

The initial summer session's objectives were (a) to bring students up to the required level of competency in the mathematics and physics to be used in the engineering courses which would follow, and (b) to give them a brief exposure to current Fortran programming techniques.

Objectives of the final summer session were (a) to give students an intensive "hands-on" laboratory experience and (b) to give them an opportunity to complete an actual individual design project.

2. Curriculum

The academic portion of the 1976-78 UC Davis Extension Women in Engineering Program was conducted between July 9, 1977 and July 8, 1978. It was broken into three main divisions: (a) an initial two-week summer session in residence at UC Davis, (b) twenty-six weekend sessions in Berkeley (taught at the Lawrence Hall of Science and Evans Hall at UC Berkeley) and (c) a final two-week summer session in residence at UC Davis.

Schedules of the two summer sessions are included. The weekend sessions were on a pattern of two weekends of classes followed by one free weekend; then another two weekends of classes and another free

weekend. Students attended class two out of three weekends. Class weekends lasted from 9:30 a.m. to 5:00 p.m. Saturday and from 9:30 a.m. to 5:00 p.m. Sunday. Short breaks were scheduled midmorning and mid-afternoon with an hour for lunch.

a. Summer Session I (July 9-24, 1977, University of California, Davis)
Mathematics Review (32.5 hours) Instructor: Michael A. Soderstrand, Ph.D., Assistant Professor, Department of Electrical Engineering, University of California, Davis.

An intensive review of mathematics through differential equations.

Physics Review (15.5 hours) Instructor: Walter Wycoff, Ph.D., Research Associate, Crocker Nuclear Laboratory, University of California, Davis.

An intensive review of the principles of physics.

Introduction to Fortran Programming (10 hours) Instructor: Nell E. Dale, Ph.D., Associate Professor, Department of Computer Science, University of Texas, Austin.

An introduction to Fortran programming.

b. Weekend Courses (August 6, 1977 through May 13, 1978)
(The following four courses were taught at the Lawrence Hall of Science, Berkeley, California):
Engineering Mathematics (4.5 days, August 6 through September 10, 1977)
Instructor: Dr. Michael A. Soderstrand

A continuation of material encountered in the earlier math course with additional concepts pertinent to electrical engineering.

X17.1 Circuits (8.5 days, August 14 through November 12, 1977) Instructor: Earle W. Owen, D. Eng. Sci., Associate Professor, Department of Electrical Engineering, University of California, Davis.

(Equivalent to UC Davis E17, 3 credits) Basic circuit analysis techniques, transient and steady state solutions using differential equations.

X35.1 Statics (5.5 days, September 11 through October 29, 1977) Instructor: Michael Taylor, Ph.D., Associate Professor, Department of Civil Engineering, University of California, Davis.

(Approximately equivalent to UC Davis E35, 3 credits) Force systems and equilibrium conditions with emphasis on engineering problems.

X45.1 Properties of Materials (7 days, November 13 through December 11, 1977) Instructor: Edward B. Evans, Ph.D., Associate Professor, Department of Civil Engineering, University of the Pacific, Stockton, California.

(Approximately equivalent to UC Davis E45, 4 credits) Introductory course on the properties of engineering materials and their relation to the internal structure of materials.

(The following courses were taught at Evans Hall, University of California, Berkeley):

X100.1 Electronic Circuits (7 days, January 14 through March 18, 1978) Instructor: Dr. Michael A. Soderstrand; Laboratory Assistant: Edward Fields, Associate-in-Engineering, Department of Electrical Engineering, University of California, Davis.

(Equivalent to UC Davis E100, 4 credits) Introduction to the theory and application of analog and digital circuits and systems. Laboratory included.

X112.1A Linear Systems Analysis (7 days; January 15 through March 19, 1978) Instructor: Rene Marxheimer, M.S., Professor, Department of Electrical Engineering, San Francisco State University.

(Equivalent to UC Davis EE112A, 3 credits) Properties and classification of linear systems--characterization and analysis of discrete and continuous time systems.

X171.1 Computer Structure and Microcomputers (7 days, April 1 through May 13, 1978) Instructor: Sandra E. Hutchins, Ph.D., Senior Scientist and Engineering Manager, LINKABIT Corporation, San Diego, California; former Assistant Professor, Purdue University.

(Approximately equivalent to UC Davis EE170, 3 credits) Computer architecture, machine assembly language, microcomputers and microprocessors.

c. Summer Session II (June 25 through July 8, 1978, University of California, Davis):
X150.1 Instrumentation Systems (23 hours lecture; 33 hours laboratory) Instructor: Dr. Earle Owen: Laboratory Instructor: Edward Fields

(Approximately equivalent to UC Davis EE150, 3 credits) Analytical and design methods common to all instrumentation systems; dynamic response; transducers; signal conditioning. Laboratory included.

d. Additional Topics:
(This course was optional and was taught at Bechtel Corporation, San Francisco):

Engineering Economics (6 hours) Instructor: John B. Ruzek, Engineer, Bechtel Corporation, San Francisco.

An introduction to the analysis of problems in engineering economy; the selection of alternatives; replacement decisions. Compounding, tax, origins and cost of capital, economic life, and risk and uncertainty are applied to methods of selecting most economic alternatives.

TABLE 1: GRADES

CODE NO.	CIRCUITS	STATICS	PROPERTIES OF MATERIALS	ELECTRONIC CIRCUITS	LIN. SYS. ANALYSIS	COMP. STRUC. MICRO-COMP	SYS. OF INSTRUMENT.
001	A-	B	B	C	C	A-	A
002	A	A-	B	B	C	C	A
003	A+	A	A	B	A	A	A
004	A	B	B+	B	B	A-	A
005	A-	D	I	I	I	I	I
006	A+	A	A	A	A	A-	A
007	A	C	A	B	B	B+	A
008	A+	A	B	A	A	A	-
009	A-	A-	A-	A	B	A+	A
010	A	C	A	B	B	B+	A
011	A-	B+	C+	B	C	C	A
012	A-	B	B+	C	B	B	A
013	B	D	B	B	B	B+	A
014	A	B	B+	A	C	B	A
015	A	B	B+	B	B	A-	A
016	A-	A	A-	B	B	-	-
017	A-	B	A	A	A	A	A
018	A+	A-	A	A	B	A	A
019	A+	A	A-	A	A	A	A
020	A	A	A	A	A	A	A
021	B	B	B	C	C	B	A
022	A+	A-	A-	A	A	B	A
023	A	B+	B	A	C	C	A
024	A+	A	A-	A	A	A+	A

TABLE 1: GRADES

CODE NO.	CIRCUITS	STATICS	PROPERTIES OF MATERIALS	ELECTRONIC CIRCUITS	LIN. SYS. ANALYSIS	COMP. STRUC. MICRO-COMP	SYS. OF INSTRUMENT
025	B	B	A-	C	C	C+	A
026	A	B	C+	B	A	I	-
027	A-	C	A	C	B	B	-
028	A-	B	A-	B	C	B-	A
029	-	I	I	-	-	-	-
030	-	-	-	-	-	-	-
031	-	C	-	-	-	-	-
032	-	-	-	-	-	-	-
033	B	B	B+	-	-	-	-
034	-	-	-	-	-	-	-
035	A	A	B+	-	-	-	-
036	-	F	-	-	-	-	-
037	-	C	-	-	-	-	-
038	-	-	-	-	-	-	-
039	-	-	-	-	-	-	-
040	-	-	-	-	-	-	-

TABLE 2: COURSE OUTLINES

X17.1 CIRCUITS (same as ENGR 17, UC Davis) 3 hours credit
Instructor: Earle Owen, Associate Professor, Electrical Engineering, UC Davis

Signals: periodic signals, averages, sampled signals
Circuit Analysis: the lumped circuit, energy and power, the ideal resistor and sources, the circuit graph, the circuit laws, independence of variables and equations, solution of the equations
Node and Mesh Analysis: node voltages, mesh currents, the use of the circuit graph, dependent sources
Equivalent Circuits: driving point and transfer relations, Thevenin and Norton equivalents, superposition, symmetry, source splitting
Energy Storing Elements: the ideal capacitor and inductor, energy and power, simple waveforms
Response of Circuits with Energy Storage: formulation of differential equations, natural frequencies, constant inputs, notched circuits
Network Functions: driving point and transfer relationships, the complex frequency model, stability, network response
AC Analysis: analysis with phasors, impedance and admittance, power, three phase systems, impedance matching
Frequency Response: poles and zeros, frequency plots

Text: Introduction to Circuit Analysis, Timothy N. Trick

X35.1 STATICS AND DYNAMICS (same as ENGR 35, UC Davis) 3 hours credit
Instructor: Michael A. Taylor, Associate Professor, Civil Engineering, UC Davis

Forces, moments, couples and resultant of force-moment systems
Equilibrium of particles and rigid bodies
Equivalent systems
Centroids and center of gravity
Trusses
Frames and machines
Beams
Fluid statics
Area moment of inertia
Friction
Virtual work
Flexible cables

Text: Vector Mechanics for Engineers: Statics, Beer and Johnston

X45.1 PROPERTIES OF MATERIALS (same as ENGR 45, UC Davis) 4 hours credit
Instructor: Edward Evans, Asso. Prof., Civil Engineering, University of the Pacific

Materials structure, binding, review of basics
Periodic table, crystal structures
Phase diagrams, diffusion, engineering alloys
Ceramics, plastics
Electrical properties
Magnetic properties; optical and thermal properties

Text: Engineering Materials and their Applications, Flinn and Trojan

X100.1 ELECTRONIC CIRCUITS (same as ENGR 100, UC Davis) 4 hours credit
Instructor: Michael Soderstrand, Adj. Asst. Prof., Elec. Engr., UC Davis

Lecture DIGITAL CIRCUITS AND SYSTEMS
Digital Systems Fundamentals: switching variable, logic assignment, basic operations, switching functions, switching algebra theorems, representation of numbers, arithmetic operations, coding in digital systems
Combinational Circuits: basic gates, characteristics of a practical gate, design considerations, other types of gates, synthesis of switching functions, implementation using NAND, NOR gates, analysis of NAND-NOR logic, simplification of switching functions
Sequential Circuits: types of sequential circuits, flip-flops, shift-registers, parity checking circuits, state table and state diagram, counters, synthesis of sequential circuits, sequence generation and detection
ANALOG CIRCUITS AND SYSTEMS
Amplifiers: basic concepts; classification of amplifiers; voltage, current, and power gains; voltage amplifiers; simple applications of voltage amplifiers; characteristics of a practical amplifier; performance of a terminated amplifier; frequency limitations, nonlinear distortion; stability; types of IC amplifiers
Operation Amplifiers: ideal model, simple applications, characteristics of a practical operational amplifier, effect of input, output impedances and finite gain, input offset and drift errors, common-mode rejection, analog computation, active inductorless filters
Analog Multipliers: ideal model, simple applications, characteristics of a practical multiplier
ANALOG-DIGITAL AND DIGITAL-ANALOG CONVERTERS: basic concepts, simple converter circuits

Laboratory
Experiments: introduction to laboratory instruments
Digital Circuits and Systems: introduction to digital IC gates, combinational circuits, flip-flops and sequential circuits, counters, display devices, and applications
Analog Circuits and Systems: resonance and passive filters, introduction to operational amplifiers, applications of operation amplifiers, active and passive RC networks
Analog-Digital Converters: A/D converters and D/A converters

Text: E100 Course Notes, M. Soderstrand, and E100 Lab Notes, Sanjit Mitre

X112.1A LINEAR SYSTEMS ANALYSIS (same as EE 112A, UC Davis) 3 hours credit
Instructor: Rene Marxheimer, Professor, Elec. Engr., San Francisco State

Linear Systems: classification, models, time domain solution of linear differential equations, linear difference equations, solution of difference equations, solution of difference equations
Convolution: convolution in discrete time solutions, impulse response, similarity functions, convolution in continuous time systems
State variables: state variable description of discrete time systems, solution of the state equations (discrete), the state matrix, solution of the state model (continuous), application to networks

Text: Signals and Linear Systems, Gabel and Roberts

X165.1 COMPUTER STRUCTURES AND MICROCOMPUTERS (same as EE 171, UC Davis) 3 hrs. credit
Instructor: Sandra Hutchins, Ph.D., Linkabit Corporation, San Diego

Description of the architecture of a simple conventional computer: central processing unit (CPU), memory, input/output devices and channels, interrupt structure
Machine and Assembly Language: data representation, instruction set, addressing techniques
Assembly Process: macros, conditional assembly, pseudo-instructions, symbolic addresses, routine and subroutines, absolute and relocatable assembly
Assemblers
Loading Process: subroutine linkage, loaders
Assembly Language Programming Techniques: re-entrant code
Simulation of a computer

Text: Computer Organization and Programming, C.W. Gear

X150 SYSTEMS OF INSTRUMENTATION (same as EE 150, UC Davis) 5 hours credit
Instructor: Earle Owen, Associate Professor, Electrical Engineering, UC Davis

Lecture

Introduction: elements of the systems, standard errors
Transducers: self-regulating, variable resistance, variable inductance, variable capacitance
Transducer Circuits: deflection and null measurements, the potentiometric method, bridges and dividers
Dynamic Error: first order, record order, frequency and step response, amplifiers
Instrumentation Amplifiers: differential measurements, d-c amplifiers, operational amplifiers
Interference and Noise: capacitively and industively coupled interference, shielding, grounding, power systems
Analog to Digital Conversion: sampling, quantizing, multiplying, types of converters
Rate and Time Interval Measurements: the sources of these signals, converters, measurements
The Small Digital Computer: review of the structure of the small digital computer
Applications of the Computer Measurement: off-line vs. on-line, open loop and closed loop
Interfacing the Computer to the System: the structure of interfaces, interrupts, direct memory access, the IEEE 488 standard, the CAMAC standard

Laboratory

Approximately 60 hours is spent in laboratory work during a two-week period. During the first week the students work on a number of prepared projects that have been used in existing courses in the electrical engineering curriculum. The second week is spent on individual projects.

5. Comments

a. Curriculum Changes:

The curriculum as outlined in the original grant proposal called for two summer sessions plus 26 weekends devoted to the study of fundamental required courses which comprise the foundation of most standard engineering majors:

Course Titles	Number of Weekends
1. Circuits	3
2. Statics	3
3. Properties of Materials	4
4. Electronic Circuits & Systems	4
5. Dynamics	3
6. Elementary Fluid Mechanics	3
7. Mechanics of Materials	3
8. Thermodynamics	3
	26

After meeting with the program's Advisory Committee it was decided that such a curriculum would not be satisfactory to employers of engineers, who wanted graduates with more specialized course work.

A revised curriculum was designed and subsequently advertised to potential participants. The revised schedule called for the same initial summer session and a core of six courses. All the participants would be required to take the first three core courses:

Circuits
Statics
Properties of Materials

At the Christmas break there would be a branch and students could opt for an electrical engineering sequence:

Electronic Circuits
Linear Systems Analysis
Computer Structure and Microcomputers

or a mechanical engineering sequence:

Dynamics
Thermodynamics
Mechanical Design

The group would then merge again for the final summer session during which they could do project work in instrumentation systems or mechanical design.

During the process of selecting the participants it became evident that the overwhelming majority preferred the electrical engineering option and that it would not be economically feasible to offer the mechanical option to so few students. The ME option was dropped at that point (about April 1977) and the potential participants notified that only electrical engineering would be available to them.

b. Teaching Approach:

The instruction throughout the program was an intensified version of traditional techniques. Lecture, demonstration, some films, and laboratories were employed. There was no self-paced or individualized instruction, however, a unique feature of the mathematics review course taught during the first summer session and the first few weekends, was the use of a math review study guide which included pre- and post-tests. The students typed their answers into computer terminals and were able to receive immediate feedback on their level of achievement. The instructor could also monitor the progress of the class and be alerted to specific topics which were consistently being missed. Such feedback allowed him to modify the next day's lecture to emphasize appropriate problem areas.

One variance from usual approaches was the somewhat greater than usual use of take-home examinations. Most of the instructors had no previous experience teaching their standard courses in a weekend format, but they adjusted quickly.

III. B. Format

The format of Women in Engineering was important in attracting participants but also imposed great limitations on the amount of contact time available with the students.

Figure III.1
OVERALL PROGRAM FORMAT

Summer Session I	2 weeks full-time	U.C. Davis campus	July 9-July 24, 1977
Weekend Sessions	26 weekends Sat & Sun 9-5	Lawrence Hall of Science/ Evans Hall, U.C. Berkeley	August-May 1977-1978
Summer Session II	2 weeks full-time	U.C. Davis campus	June 25-July 8, 1978

The two summer sessions were kept to two weeks so that women with jobs could attend during their regular vacation and would not need to miss work. It was also felt that women with children would not be able or willing to be separated from their families for longer than about two weeks. As it turned out, these assumptions proved to be true. Several women had to return home briefly to attend to family or job emergencies.

It would have been very helpful to have had at least one more week during Summer Session I so that the students could have had more math and physics instruction as well as more time for computer programming and electrical engineering laboratory experience. However, the reasons for limiting the session to two weeks were so important that the session was kept to two weeks when the program was repeated in summer 1978.

The students lived and ate their meals in the U.C. Davis residence halls and attended classes in Bainer Hall, the engineering building, and in Roessler Hall, the physics building, during the summer session. Except for the very accelerated pace, this experience was very similar to that of any traditional

on-campus engineering students. The participants ate and studied together without the distractions of family or job. They provided a good deal of emotional support to each other.

The bulk of the program during during August through May used a very different format. Living all over the Bay Area and in Sacramento, the participants commuted to a central location to attend classes, then returned to their homes during the week. Until Christmas, courses were taught at the Lawrence Hall of Science in the Berkeley hills. Lawrence Hall is an imposing structure with excellent instructional facilities as well as numerous scientific displays and teaching laboratories which are open to the public.

Because the students spent so much time in the building, they became bored and requested a change of scene. Accordingly, after Christmas courses were moved to Evans Hall, one of the U.C. Berkeley engineering buildings.

The courses were generally taught two at a time for a ten week period.

Figure III.2
FORMAT FOR WEEKEND COURSES

Week	1		2		3	4		5		6	7		8		9	10	
Day	Sa	Su	Sa	Su	Sa Su	Sa	Su	Sa	Su	Sa Su	Sa	Su	Sa	Su	Sa Su	Sa	Su
Course	A	B	A	B	Free	A	B	A	B	Free	A	B	A	B	Free	A	B

The first course was taught from 9:30 a.m. - 5:00 p.m. on Saturday and the second course was taught during those same hours on Sunday. Because the faculty, as well as the students, commuted to Berkeley, it was not feasible to teach half a day of each course on both Saturday and Sunday. From an educational point of view this latter approach would have offered many advantages. However, the costs involved and the lack of willingness of professors to give up <u>both</u> days of their weekend for seven weekends made that schedule impractical.

Attending class two out of three weekends, while working full-time and

having a family was a situation which pushed the participants to the edge of their capabilities. Many students reported health problems and conflict in their families. It is highly doubtful that many people could or should maintain this pace for more than this one year period.

It would have been useful to have had more time available for instruction and for other support activities, but the staff believed that the students could not be asked to attend class longer than 9:30 a.m. to 5:00 p.m. or to attend class more often than two out of three weekends. No additional activities could be planned on weekdays because participants, staff, and instructors were widely dispersed geographically.

III. C. Support and Professional Development Services

The support services provided by the program focused on three areas:

1) Family: activities oriented toward informing families about the nature and requirements of the program and activities to increase the families' feelings of involvement in the program. All of this was an effort to decrease family resistance to having to give up the time and energy their wife or mother had to spend in her studies during the year.
2) Personal Support: These activities were aimed at helping students deal with problems arising out of participation in the program, such as academic difficulties, family problems, concerns about career changes, etc.
3) Support the student's emerging sense of herself as an engineer: activities to provide her with role models after which she could pattern her new professional image and activities to help her recognize and deal with the problems facing women engineers who work in a predominently male environment.

Much of the support service was blended in with other aspects of the program. For example, the scheduling of weekend sessions was arranged in such a way that participants could spend important holidays and vacation periods with their families. Wherever possible, women instructors and speakers were used so that the participants would have a chance to have natural contact with women professionals. Dr. Sandra Hutchins, Dr. Nell Dale, and Dr. Adele Sheeley were especially effective in this area.

1. Family Activities

During the first summer session two family activities were offered. A tram tour of the U.C. Davis campus gave families some background about the University and gave them a chance to get acquainted with each other. On the final day, participants' families attended an afternoon picnic, at which time they met the program staff, some of the faculty, and some members of the Advisory Committee. They were told more about the program and what they

could expect during the coming months.

The families attended another social event for the program in December at the conclusion of the second set of courses. Everyone gathered at the Faculty Club at U.C. Berkeley for a Christmas buffet.

At the conclusion of the second summer session, families and friends were encouraged to attend the commencement luncheon and ceremony.

Outside of these organized activities, families also were involved as they met students in the informal study and carpool groups which evolved. A few husbands and children sat in on some of the weekend courses, especially those taught at Lawrence Hall of Science, where there were many other things to see and do after they tired of the courses.

2. Personal Support

Because of the intensive nature of the program, participants were put under considerable stress. It was originally planned to offer individual and group counseling to help with the resultant problems. In actual practice, however, individual counseling was difficult because of the structure of the program. The women lived in widely scattered locations and only came together on weekends. Their weekend time was filled with engineering classwork, so the only chance the coordinator had to talk with participants was during the brief breaks and during lunch. Some counseling was also done by phone. The women themselves seem to have filled the void somewhat. They formed carpools and during the commutes to and from Berkeley they had a chance to talk and provide peer support.

3. Professional Development

A number of professional development activities were conducted throughout the year. The full day "Successful Careering" program during Summer Session I gave participants an excellent introduction to the less well known aspects of furthering one's career. During that same summer they were also taken on a full day tour of IBM and Hewlett-Packard. At both companies they had a chance to see engineers at work and were able to meet and talk with practicing women

engineers. During the fall, the participants heard from six different women engineers who talked about what they did and about how they had handled the problems arising out of being a woman in a male-dominated field. In addition, the women were encouraged to join and attend meetings of the Society of Women Engineers, where they could begin to fit into the network of women professionals.

The sessions on resume writing and interviewing taught skills which were not only useful in getting the first engineering job, but which will help the women as they make later job changes.

One session was devoted to a presentation of information on various graduate programs both in engineering and in business management. Heavy emphasis was placed on continuing education throughout the year.

A unique aspect of this program's professional development agenda was the encouragement of participants to prepare for and take the California State Engineer-in-Training Examination, which is the first step toward becoming a registered professional engineer. It should be noted that practicing electrical engineers - especially those in the electronics and computer areas - usually are not registered. Registration is most common for civil and mechanical engineers. Nonetheless, it was felt that passing the E.I.T. test would be a good indication of the program's effectiveness and would give those who succeeded a recognized engineering "credential." The women were referred to books aimed at preparing students for the E.I.T. and toward locally available preparation courses. In addition, one whole day was devoted to an E.I.T. preparation program on the topic of Engineering Economics. It was felt that this material would be of general use to the women as engineers and would help them pass the examination. The course was taught by John Ruzek, P.E., of Bechtel Corporation. Mr. Ruzek regularly offers this same material as part of an Engineer-in-Training preparation course for Bechtel employees. Six participants took the E.I.T. examination in the spring and five of the six passed it.

Throughout the year, local professional meetings and conferences were announced and the women were encouraged to become involved. Many became members of the Society of Women Engineers, the Institute of Electrical and Electronic Engineers, and the Society of Professional Engineers. During fall 1977 approximately 12 of the women attended a full day micro-electronics

seminar conducted at the University of the Pacific by the Bay Area Hybrid Microelectronics Society. Later in the year about twenty participants took part in the huge annual WESCON - Western Electronics Conference - held in San Francisco.

Even given the minimal time available for extra-curricular activities, the support and professional development portion of the program turned out to be one of the most important and successful aspects of the Women in Engineering program.

III. D. Co-operative Engineering Education Jobs

CO-OP positions in industry were offered an as optional part of the Women in Engineering Program. The CO-OP program was explained in detail during Summer Session I. Twenty - one students expressed an interest in these positions which would be full-time paid engineering training jobs. Fifteen students were successful in being selected for CO-OP positions. Of the remainder, several took permanent engineering positions instead and several others remained at their previous places of employment.

During Summer Session I interested students received advising from the Project Coordinator and completed "Personal Resume" and "Academic Preparation" forms. At the same time letters and response forms were mailed to over 200 employers of electrical engineers in the San Francisco Bay Area. These letters invited companies to indicate their willingness to employ CO-OP students.

During late August and September 1977, Dr. James Herschinger was employed on a temporary basis to coordinate CO-OP placement.

Ten of the CO-OP students have completed "Student Evaluation of Co-operative Education Experience" forms, which supply the following information about their jobs:

Student	Employer	CO-OP Salary
C.B.*	IBM-General Products Division San Jose, CA	$980/month
S.G.	United Technologies-Chemical Systems Coyote, CA	$915
M.G.*	Ford Aerospace & Communications Corp. Palo Alto, CA	$985
J.H.*	IBM-General Products/LSI Technology Los Gatos, CA	$1125
S.L.	Bechtel Corporation-San Francisco Power San Francisco, CA	$1000
S.L.	Mare Island Naval Shipyard Naval Electronics Systems Command Vallejo, CA	$755

Student	Employer	CO-OP Salary
C.S.	Bechtel Corp.-Control Systems Division San Francisco, CA	$1050
S.S.*	IBM-General Products Division San Jose, CA	$1144
P.S.	IBM-General Products Division San Jose, CA	$988
D.T.	California Energy Commission-Conservation Division Sacramento, CA	$930

Average CO-OP Salary = $987.20

Reported salaries ranged from $755 for a federal civil service job, to $1,144 for a position in private industry.

Other CO-OP students who did not complete the form are:

R.S.*	Daytron, Inc. Mountain View, CA
D.H.	IBM-General Systems Divsion San Jose, CA
P.G.	United Technologies-Chemical Systems Sunnyvale, CA
R.R.	U.S. Geological Survey-Water Resources Sacramento, CA
W.H.	IBM-General Systems Division San Jose, CA

*Students who subsequently accepted permanent jobs with their CO-OP employers (N=5, or 33%)

The promotional brochure had indicated that CO-OP earnings would "range upwards from $700.00 per month," but actual salaries turned out to be considerably better than that estimate. NSF Women in Engineering participants' salaries at an average of $987.20, are somewhat higher than CO-OP salaries earned by regular electrical engineering students from the University of the Pacific in Stockton, California. The UOP seniors earned $876 in their fourth year of college and $1111 in their fifth year when working at similar co-operative education jobs.

The majority of the NSF CO-OP students worked from November, December, or January through May. As indicated on the employer listing above, five students (or 33%) later accepted permanent jobs with their CO-OP employers.

While the combination of working full-time at a new technical job and simultaneously going through an intensive academic program all weekend has been a tremendous strain on many of the participants, the co-operative education jobs nevertheless are extremely important. This recent technical experience added to recent engineering education has helped these women get off to a better start in looking for permanent employment.

III. E. Job Placement

From the beginning it was assumed that a majority of the participants would be seeking full-time engineering positions immediately upon completion of the program. This assumption has turned out to be true. Only one woman expected to enter graduate school full-time; the others expected to work, although not all in engineering.

The placement activities began in the first summer session with one whole day--the second day of the session--devoted to a "Successful Careering" workshop conducted by consultant Adele Sheeley of Social Engineering Technology in Los Angeles. During the rest of the summer session, the participants attended three other group meetings aimed at preparing them for success in later job hunting:

a) Opportunities in Electrical Engineering - Prof. Richard Dorf discussed the current job market for EE's, salaries, types of jobs, etc.
b) The Placement Process - Prof. Donna Frohreich gave an outline of various strategies for job seeking, specific details about services the program would provide, references to helpful publications and placement organizations, and advice on what participants could begin doing immediately.
c) UC Placement Center - a tour of the Placement Center and a discussion of its services by the director. Participants were also advised to make use of the placement services of their undergraduate institutions.

Placement-oriented activities continued in the fall with distribution of College Placement Annuals and UCD Placement Manuals, a seminar on effective resume writing conducted by Donna Frohreich in October, and a seminar on interviewing techniques in November. During the interview workshop, a representative of Lawrence Berkeley Laboratories discussed what a research-oriented organization seeks in prospective employees; Becky Bjustrom, chemical engineer from the Department of Energy, provided reactions from the viewpoint of a woman engineer who has recently gone through the interview process; and Terry Francino, Employment Manager of Proctor and Gamble in Sacramento, conducted an actual in-depth employment interview with one of his young woman managers assuming the role of applicant.

In September twenty of the students attended the annual WESCON (Western Electronics Conference) meeting in San Francisco, a part of which dealt with job-hunting for engineers.

Throughout the fall and spring Donna Frohreich provided individual critiques of students' resumes and counseled with participants as they began making job applications, being interviewed, and going on plant visits. She also referred students to interested executive search firms and organizations which set up interviewing conferences, such as Interstate Staffing, Inc., of Pennsylvania, and Lendman Associates. Such contacts will be sources of help to the women throughout their careers, long after the NSF program is no longer available for assistance.

CO-OP: The main objective of the co-operative engineering jobs was to provide the students with on-the-job engineering training and experience in applying for jobs. This element of the program was an important part of the placement plan. As it turned out, five of the fifteen co-op students later accepted permanent jobs with their co-op employers.

Placement Brochure: One of the activities we expected to be especially productive in terms of employer contact was the "Placement Brochure." It contained resumes of any participant who wished to be included. (Some chose not to submit resumes because they already had jobs or they did not want their current employer to know they were seeking other positions.) The brochure also contained a cover letter and description of the program.

Eight hundred copies of the brochure were printed and were distributed to:

a) 350 company representatives who have previously paid $50 per copy for a similar publication from Purdue University's Society of Women Engineers.
b) Approximately 200 employers of electrical engineers in the San Francisco Bay Area, since most of our participants wish to remain in that area. Names come from the Bay Area Employer Directory by James P. Albin. These employers were previously sent information about the NSF program.
c) Appropriate University of California placement centers.
d) Members of the Advisory Committee and the companies who have supported the

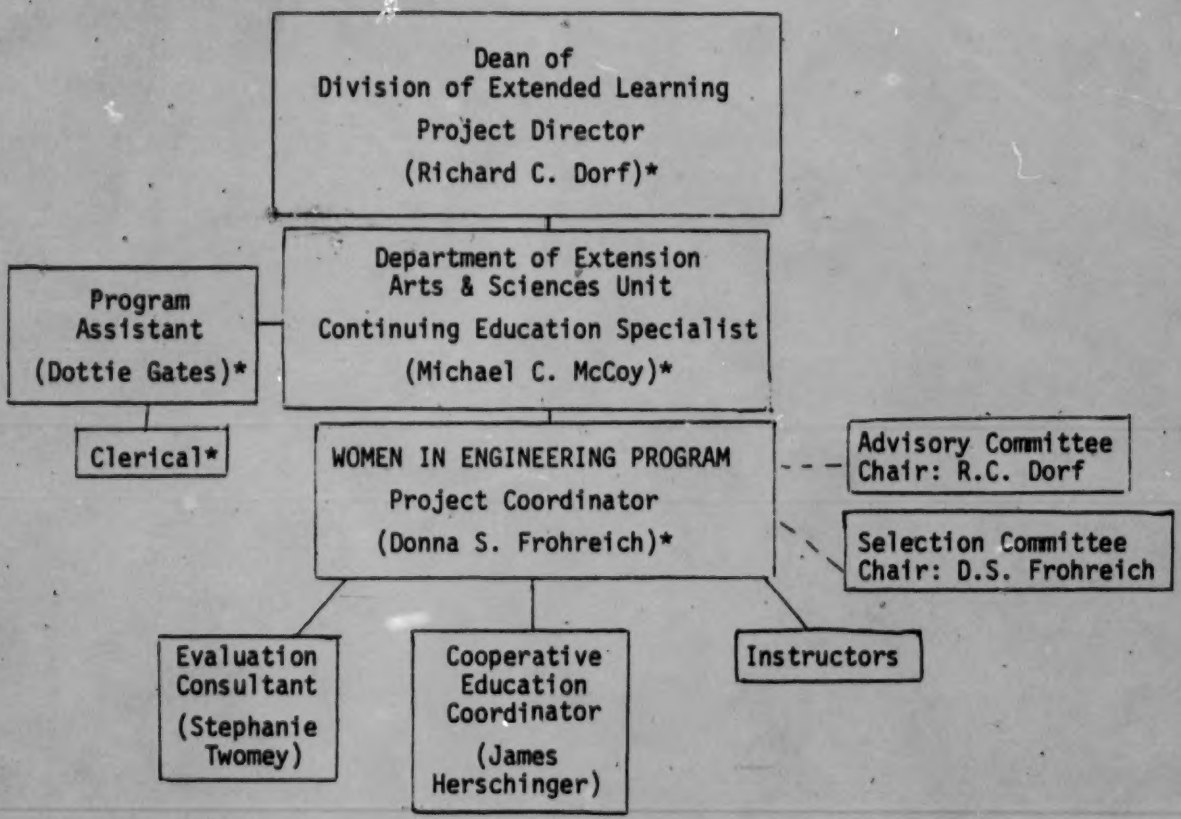
program by providing co-op jobs, speakers, or tours.

e) Upon request to any engineering employer.

The Placement Brochure proved to be an excellent way of reaching employers and the participants did receive many contacts - letters and phone calls - from companies which got the brochures. Such contacts were a tremendous morale boost for the students since they were concrete proof that employers actually were interested in them. The brochure broadened many women's job horizons as they received literature and letters of interest from companies about whom they had previously known very little.

III. F. Organization and Staff Data

The following chart outlines the responsibility relationships of program personnel:



The original design for the UC Davis NSF Women in Engineering Program was a joint effort of Richard C. Dorf, Donna S. Frohreich, and Michael C. McCoy, and the bulk of the later decision-making was assumed by these three people with the advice of the Advisory Committee. Program faculty were engaged after the project had already been set up. Faculty input was solicited as the program progressed and their suggestions were followed in modifying the program for 1978-80.

*Regular Extension staff.

The specific duties of individual staff members are indicated on Table 3. It should be noted that the Advisory Committee was not compensated for its contributions (except for Dr. Hutchins when she served as an instructor).

TABLE 3: STAFF RESPONSIBILITIES

Staff Responsibilities	Initial Planning	Curriculum Revision	Promotion Recruiting Selection	Educational Delivery System	Instruction	Co-op Job Placement	Social Support Professional Development	Job Placement	Evaluation	Dissemination
Administrative:										
R. C. Dorf (Project Director)	X	X	X		X		X	X	X	X
M. C. McCoy (Continuing Education Specialist)	X	X	X	X		X		X		
D.S. Frohreich (Project (Coordinator)	X	X	X		X	X	X	X	X	X
D. Gates (Program Assistant)			X	X		X		X		
Instruction:										
N. Dale					X		X			
E. Evans					X					
E. Fields					X					
S. Hutchins		X			X		X	X		
R. Marxheimer					X					
E. Owen					X					
J. Ruzek					X					
M. Soderstrand					X					
M. Taylor					X					
W. Wycoff					X					
Advisory Committee (not paid) (see listing for complete committee)										
Pastre		X	X				X			
Peters		X	X				X			
Hutchins		X			X		X	X		
McDonald		X					X			
Panepinto		X					X			

TABLE 3 (cont.)

	Initial Planning	Curriculum Revision	Promotion Recruiting Selection	Educational Delivery System	Instruction	Co-op Job Placement	Social Support Professional Development	Job Placement	Evaluation	Dissemination
Consultants:										
J. Hershinger						X				
A. Sheeley							X			
S. Twomey									X	

BACKGROUND DATA ON STAFF AND FACULTY

1. Administrative

a. Richard C. Dorf - Project Director

Dr. Richard C. Dorf is Dean of the Division of Extended Learning and Professor of Electrical Engineering at the University of California, Davis. He received his B.S. from Clarkson College of Technology in 1955, his M.S. from the University of Colorado in 1957 and his Ph.D. from the U.S. Naval Postgraduate School in 1961; all in electrical engineering.

Dr. Dorf has previously taught at Clarkson College, the U.S. Naval Postgraduate School, the University of Edinburgh, Scotland; the University of Santa Clara and Ohio University. Dr. Dorf served as chairman of electrical engineering at the University of Santa Clara from 1963 to 1969 and was selected as Dean of the College of Engineering at Ohio University in 1969. Dr. Dorf immediately assumed the position of Vice President for Educational Services at Ohio University and served from 1969 to 1972. He joined the University of California, Davis, as Dean of Extended Learning in 1972.

Dr. Dorf's research is in the field of automatic control systems and computers as well as the study of the social implications of engineering developments.

Dr. Dorf is the author of six books, among which are: Computers and Man (1972), Modern Control Systems (1967 and 1974) and Technology, Society, and Man (1974), Energy, Resources, and Policy (1977), and Appropriate Visions (1978).

Dr. Dorf has previously received six NSF grants to offer NSF conferences for college teachers on 1) time domain methods (1966 and 1967), 2) modern control theory and (1967) and, 3) engineering and the technological society (1969, 70, and 71).

b. Donna S. Frohreich - Project Coordinator

Donna S. Frohreich has served as the Project Coordinator for the UC Davis "Women in Engineering" program since it was funded in July 1976. She was also an Assistant Professor in the School of Engineering at the University of the Pacific, where she was Director of Student Development and Coordinator of Cooperative Education. From 1968 until 1975 she was Assistant Professor in the Department of Freshman Engineering at Purdue University and served as Coordinator of Programs for Women in Engineering. Ms. Frohreich earned an A.B. degree (with Distinction) in sociology from Stanford University in 1965 and a Master of Arts degree in Education (Counseling and College Student Personnel Administration) from the same institution.

At the University of the Pacific Ms. Frohreich coordinated the placement of engineering students in cooperative education positions; conducted conferences and seminars for high school and community college teachers, counselors and students; and advised the student section of the Society of Women Engineers.

In her seven years on the faculty at Purdue University Ms. Frohreich directed an extensive program to attract and retain women students in engineering. Her activities as part of this program included developing recruiting materials; organizing conferences; counseling women students; setting up scholarship and fellowship programs; speaking to groups of students, teachers, and parents; seeking funding for the program; planning program budget; and developing and maintaining contacts with engineering employers. During the time she was at Purdue the enrollment of women engineers increased form a total of 46 in 1968 to approximately 450 in 1975.

At Purdue she designed and taught a course on study methods for engineering students and set up a special mini-course on "Successful Job-Hunting Techniques for Engineers" (aimed at women students). She

D.S. Frohreich - cont.

developed and taught an "Engineering Seminar for Women", an elective course giving freshman women an opportunity to meet a series of practicing women engineers from various disciplines and industries. This course was successful enough to be continued up to the present time.

Donna Frohreich was named 1974-75 "Dow Outstanding Young Faculty Member" from the Illinois-Indiana section of the American Association for Engineering Education. She currently serves as the chairperson for the Women's Action Group of the ASEE's Relations With Industry division. She has conducted workshops and presented sessions on women in engineering at several ASEE national conventions. Her article, "How Colleges Try to Attract More Women Students," appeared in the February 1975 IEEE Transactions on Education.

c. Michael C. McCoy - Extension Specialist

Michael McCoy is currently Continuing Education Specialist in the Science and the Environmental unit of University Extension. He received his B.A. From California State University, Sacramento, 1968, and his M.A. from the University of Illinois, Urbana, 1969.

Mr. McCoy has previously served as a research assistant for the University of Wisconsin Extension, Department of Program and Staff Development and has taught communication at the University of Wisconsin and the University of Illinois. Mr. McCoy has also produced educational materials in the public and private sectors and has conducted research on Human Factors Design in classroom spaces.

Mr. McCoy has served as education specialist and administrator for the U.C. Davis "Women in Engineering" program since July 1976. His role in the program has included cooperation in program design, student recruitment, faculty recruitment and financial administration.

d. Dorothy M. Gates - Program Assistant

Dottie Gates has been employed as a Program Assistant in the Arts and Sciences Unit of University Extension, where her responsibilities include all facets of programming Extension classes both off and on campus. She has experience in arranging for facilities; ordering books; coordinating arrangements with course instructors; processing course approvals; communicating with students; and working with the promotion department on the promotion of all classes. Ms. Gates holds a Bachelor of Arts degree in Education from the University of Arkansas at Little Rock.

2. Faculty

The Women in Engineering Program was fortunate to have been able to obtain the services of regular senior engineering faculty members from University of California-Davis, the University of the Pacific, and California State University, San Francisco. Instructors taught the Women in Engineering courses in time beyond their regular assignments. While this put an additional burden on the faculty members, their involvement was feasible for two reasons: (1) Women in Engineering courses were offered on weekends - times when instructors had no other faculty obligations, and (2) the courses they taught for Women in Engineering were courses which they usually were responsible for on campus, so limited additional preparation time was necessary.

By being able to hire appropriate and interested instructors from several universities - instead of just one campus the program was able to assemble an outstanding group of teachers. This approach provides for very flexible staffing since it does not depend on the willingness of particular people to teach any one course. Efforts were made to locate women faculty, but none were available locally. In order to provide female professional role models, Dr. Nell Dale, from University of Texas at Austin, and Dr. Sandra Hutchins, from Linkabit Corporation in San Diego were called upon to travel to Davis or Berkeley to teach their respective courses. The program's unique format made their participation possible.

FACULTY

NELL E. DALE, Ph.D., Associate Professor, Department of Computer Science, University of Texas at Austin (Fortran Progamming)

EDWARD B. EVANS, Ph.D., Associate Professor, Department of Civil Engineering, University of the Pacific, Stockton (Properties of Materials)

FACULTY - cont.

EDWARD FIELDS, Associate-in-Engineering, Department of Electrical Engineering, University of California, Davis (Teaching assistant in Electronic Circuits; Instrumentation Systems)

SANDRA E. HUTCHINS, Ph.D., Senior Scientist and Engineering Manager, LINKABIT Corporation, San Diego; formerly Assistant Professor, School of Electrical Engineering, Purdue University (Computer Structure and Microcomputers)

RENE MARXHEIMER, M.S., Professor, Department of Electrical Engineering, San Francisco State University (Linear Systems Analysis)

EARLE W. OWEN, D. Eng. Sci., Associate Professor, Department of Electrical Engineering, University of California, Davis (Circuits; Instrumentation Systems)

MICHAEL A. SODERSTRAND, Ph.D., Assistant Professor (Adjunct), Department of Electrical Engineering, University of California, Davis (Mathematics Review; Engineering Mathematics; Electronic Circuits)

MICHAEL A. TAYLOR, Ph.D., Associate Professor, Department of Civil Engineering, University of California, Davis (Statics)

WALTER WYCOFF, Ph.D., Research Associate, Crocker Nuclear Laboratory, University of California, Davis (Physics)

3. ADVISORY COMMITTEE

Members of the Advisory Committee were chosen to provide representatives from industry, academic, co-operative education, Society of Women Engineers, and women practicing engineers. The group was an active force in curriculum revision, determining the basis for selection and in providing ideas on placement.

The members and their affiliations are listed below:

JEAN PANEPINTO, Bechtel Power Company, San Francisco, California, also former chair of the Golden Gate section of the Society of Women Engineers.

SHIRLEY MCDONALD, Lockheed Missiles and Space, Sunnyvale, California, also former chair of Bay Area section of the Society of Women Engineers.

DR. CONSTANCE MILLER, Assistant Professor, Mechanical Engineering, University of California, Berkeley, California.

JAMES T. GODFREY, Director of Training & Cooperative Extension, School of Engineering, University of the Pacific, Stockton, California.

HELEN JOYCE PETERS, Department of Water Resources, Sacramento, California

DR. ALLAN MCKILLOP, Chair, Department of Mechanical Engineering, University of California, Davis.

DR. V. RALPH ALGAZI, Chair, Department of Electrical Engineering, University of California, Davis.

DR. THOMAS WHITNEY, Hewlett-Packard, Inc., Data Systems Division, Cupertino, California.

PAMELA FAUST, Director, Commission on the Status of Women, Sacramento, California.

WALLY DECKER, Lawrence Livermore Laboratory, Livermore, California.

CAROL CUNNINGHAM, International Engineering, San Francisco, CA

GARY PASTRE, International Business Machines, San Jose, California.

JAMES BARHAM, Manager, Exploratory Systems Department, Sandia Laboratories, Livermore, California.

ADVISORY COMMITTEE - cont.

DR. SANDRA HUTCHINS, Senior Scientist and Engineering Manager, LINKABIT Corporation, San Diego, California

DONNA S. FROHREICH, Project Coordinator

MICHAEL C. MCCOY, Continuing Education Specialist

DR. RICHARD C. DORF, Project Director, Chair of the Advisory Committee

While it is difficult to judge exactly the amount of staff time spent on the Women in Engineering Program, some estimates are offered below:

Staff Category	Person-Months
Faculty	21.6
Administrators	24
Secretarial/Clerical	8.4
Other (includes evaluator, advisory committee, consultants, etc)	3

Table 4 outlines how various University of California units participated in the Women in Engineering Program.

TABLE 4.

UC DAVIS DEPARTMENTS AND UNITS INVOLVED IN NSF WOMEN IN ENGINEERING PROGRAM	Initial Planning	Curriculum Revision	Promotion/Recruitment/Selection	Educational Delivery System	Instruction	Co-op Job Placement	Social Support/Professional Development	Job Placement	Evaluation	Dissemination
Dean of Extended Learning	X	X			X		X	X	X	X
University Extension	X	X	X	X		X	X	X	X	X
Public Relations			X							
Publicity			X					X		X
Office of Dean of Engineering	X				X					
Department of Electrical Engineering		X			X					
Department of Mechanical Engineering		X								
Department of Civil Engineering					X					
Career Planning & Placement							X	X		

IV. APPLICANT DATA

Detailed information about those who began the NSF Women in Engineering Program is contained on Tables 5-9 on the following pages. Since these data are given by individual, some summary comments are in order.

Participants have been assigned identification numbers 001 through 040. The first 28 numbers are those who completed the program and received Certificates of Completion. Numbers 029 through 040 indicated women who began the program, but dropped out.

Table 5 offers demographic data on the participants. One of the most interesting and unexpected facts was the relatively large number (N=12 or 30%) who were born outside the United States. Of these, 6 or 50%, did not complete the program. Another way to look at this, is to note that 50% of the attrition is due to the drop out of women not born in the United States.

At the time the program began, the median age for the group was 35 years, with a range of 24 to 47 years of age.

One male participated in the program. He was a 33 year old native of China with a degree in mathematics. He suffered from severe language problems.

Nearly all the students (N = 38) claimed California as their state of permanent residency. One was from Oregon and one from Washington, D.C. Only two women had to relocate in order to participate in the program.

Educational Data is contained on Table 6. The participants held the following degrees:

Bachelor of Arts	17
Bachelor of Sciences	23
M.A. in Teaching	3
Master of Science	4
Master of Arts	2
Master of Business Administration	1
Master of Library Sciences	1
Total Graduate Degrees	11 (28%)

Nine participants held degrees from outside the United States. This 23% of the group had studied in:

Philippines
Egypt
Viet Nam
China

The undergraduate majors for the group as a whole were distributed as follows:

Undergraduate Majors

Mathematics	16 (40%)	Engineering Science	1
Total engineering degrees	8 (20%)	Computer Science	1
Chemistry	6 (15%)	Clinical Science	1
Chemical Engineering	4	Spanish/Chemistry	1
Electrical Engineering	3	Physical Science	1
Physics	2	Linguistics	1
Biochemistry	2	Education/Mathematics	1

There are some interesting educational differences between those who completed the program and those who dropped out.

TABLE 5: DEMOGRAPHIC DATA BY PARTICIPANT

CODE NO.	NAME	DATE OF BIRTH	AGE	PLACE OF BIRTH	PERMANENT ADDRESS
PLEASE NOTE:	Names and street addresses have been omitted to ensure the privacy of the participants.				
001		6/52	25	Hitchin, Hert. United Kingdom	Palo Alto, CA
002		5/42	35	Manila, Philippines	San Francisco, CA
003		8/43	34	Patchogue, NY	San Francisco, CA
004		10/50	27	Long Beach, CA	Cedar Falls, IA
005		7/44	33	China	Palo Alto, CA
006		2/34	43	Assiout, Egypt	Syracuse, NY
007		7/49	28	Harrisburg, IL	Richardson, TX
008		-	-	-	Foster City, CA
009		8/40	37	Urbana, IL	Menlo Park, CA
010		7/53	24	San Diego, CA	Berkeley, CA
011		4/44	33	Hiroshima, Japan	San Lorenzo, CA
012		12/49	28	Brawley, CA	Vallejo, CA
013		7/50	27	Burlington, VT	Oakland, CA
014		11/38	39	Butler, PA	Pacific Grove, CA

TABLE 5 (cont.)

CODE NO.	NAME	DATE OF BIRTH	AGE	PLACE OF BIRTH	PERMANENT ADDRESS
015		9/27	50	Dallas, TX	Sacramento, CA
016		6/52	25	Cleveland, OH	San Francisco, CA
017		10/34	43	Santa Barbara, CA	Fremont, CA
018		12/34	43	Chicago, IL	Poway, CA
019		11/40	37	Washington, DC	Sunnyvale, CA
020		8/43	34	Boulder, CO	San Jose, CA
021		4/49	28	Kansas City, MO	Los Gatos, CA
022		8/37	40	Chicago, IL	Santa Rosa, CA
023					Davis, CA
024		9/40	37	Whittier, CA	San Francisco, CA
025		10/37	40	Van Nuys, CA	Carmichael, CA
026		2/52	25	Viet Nam	San Jose, CA
027		5/30	47	Boulder, CO	St. Helena, CA
028		11/33	44	San Francisco, CA	Westlake Village, CA
029		5/48	29	Philippines	San Ramon
030		7/41	36	Viet Nam	Vacaville, CA

TABLE 5 (cont.)

CODE NO.	NAME	DATE OF BIRTH	AGE	PLACE OF BIRTH	PERMANENT ADDRESS
031		5/38	39	Philippines	San Francisco, CA
032		10/42	35	Billings, MT	Sunnyvale, CA
033		6/45	32	Palo Alto, CA	Mountain View, CA
034		10/39	38	Macao, China	San Carlos, CA
035		7/32	45	North Bergen, NJ	Cupertino, CA
036		8/47	30	Philippines	San Francisco, CA
037		10/46	31	Philippines	San Francisco, CA
038		2/50	27	Oskaloosa, IA	Palo Alto, CA
039		9/37	40	Missouri	San Francisco, CA
040		3/36	41	Philadelphia, PA	Berkeley, CA

TABLE 6: EDUCATIONAL DATA BY PARTICIPANT

CODE NO.	BACHELOR'S DEGREE				MASTER'S DEGREE				OTHER EDUCATIONAL EXPERIENCES
	DATE BA/BS	WHERE ATTENDED	MAJOR	MINOR	DATE MA/MS	WHERE ATTENDED	MAJOR	MINOR	
001	75	Univ. of Calif.-Santa Cruz	Biology Chemistry	Math Econ.					
002	62	Univ. of the Philippines	Chem. Engr.		67	Univ. of the Philippines	Ind. Mgt.		Courses in: Assembler language, Fortran Programming & Management
003	65	SUNY - Binghamton	Math	Engl.	66	Syracuse Univ.			Courses in: art, education, vector anal, differential equations, non-Euclidian Geom. and Fortran.
004	72	Univ. of Calif.-Davis	Math	Educ.					Aetna Commercial Casualty School; accounting
005	67	Nat'l Tsinghua Univ.-China	Math	Physics					
006	59	Cairo Univ.- Egypt	Elec. Eng.		73	Univ. of Calif.-Berkeley	Library Sciences	***	Courses in France: information processing & in East Germany: nuclear engineering
007	70	San Jose State Univ.	Math	Humanities					Courses in: Math & teaching credential requirements
008	(No Data)								
009	62	Concordia Teaching Col. River Forest, Ill.	Educ/ Psych	Math/ Science	66	Rutgers Univ.	Math	Sec. Educ.	Math at UCLA; NSF program in Japan (1969)
010	76	Univ. of Calif.-Berkeley	Linguis-tics	Langs./ Nat. Sci.					Courses in: Math, chemistry; Japanese and Portuguese
011	70	Cal. State Univ.-Hayward	Math						
012	73	Univ. of Calif.-Davis	Spanish	Chemistry*					*3 quarter units away from B.S. in Chem. Courses in: Atomic Physics and Physics
013	72	Univ. of Vermont	Math	Art					Short courses in: Epidemiology, interviewing, legal assistant

TABLE 6: -cont.-

CODE NO.	BACHELOR'S DEGREE				MASTER'S DEGREE				OTHER EDUCATIONAL EXPERIENCES
	DATE BA/BS	WHERE ATTENDED	MAJOR	MINOR	DATE MA/MS	WHERE ATTENDED	MAJOR	MINOR	
014	60	Grove City College Grove City, PA	Math	Phys. Sci/ Educ.					Seminary for Science teachers in Lebanon
015	54	Univ. of Arkansas	Math	Phys. Sci.					Later she earned an AA Electronic communication & Computer Tech. (1976)
016	74	N.M. Inst. of Mining & Tech.	Comp. Sci.	Geol.					Courses in: Statistics, Theater, & Music
017	56	Univ. of Calif. - Santa Barbara	Math	Phys. Sci.					1 sem. of graduate courses in math along with 60 units of counseling, psych, law, educ., communication, etc.
018	56	Univ. of Ill.	Chem.						6 courses in computer programming; Income Tax preparation
019	62 72	Stanfor University Cal. State-L.A.	Psych Math						Courses in: accounting, astronomy, Chicano studies
020	65	Colorado College	Math	French	69	Univ. of Chicago	Math Educ.		Courses in: math education, computer programming, Spanish, astronomy, photography
021	71	Dominican Col. of San Rafael	Math	Engl.					ABT in environmental studies; courses toward teaching credential
022	64	Siena Heights Col. Adrien, Mich.	Math	Chem	70	Univ. of Notre Dame Notre Dame, Ind.	Math		
023	(No Data)								
024	69	Cal. State Univ.-L.A.	Math	Phys. Sci					Courses in: Chemical engineering, analytical chemistry, transformation geometry, German, Teaching and Admin. credential

TABLE 6: -cont.-

CODE NO.	BACHELOR'S DEGREE DATE BA/BS	WHERE ATTENDED	MAJOR	MINOR	MASTER'S DEGREE DATE MA/MS	WHERE ATTENDED	MAJOR	MINOR	OTHER EDUCATIONAL EXPERIENCES
025	68	Cal Poly -Pomona	Physics	Math/ Phys. Sci.	71	La Verne College La Verne, CA	Hist./ Educ.		Courses in: general engineering, aero. engineering, and other science courses
026	75	Poly. Univ. of Thu Duc - Vietnam	Chem. Engr.	Chem.					One year course in electronic circuits
027	51	Univ. of Washington	Chem	Math	68	San Jose State Univ.	Chem	Math	Courses in: accounting
028	64	Univ. of Calif. -Berkeley	Chem						Courses in: radiologic health, electronics, data processing, chromatography, aerosol chemistry
029	69	Univ. of Sto. Tomas (Philippines)	Chem	Math					Seminars in science film and atomic energy
030	73	San Francisco State Col.	Chem. Sci.						
031	62	Mapua Inst. of Tech. (Philippines)	Chem.	Math					
032	64	Univ. of Montana	Math						System Analysis @ Univ. of Minn.
033	68	San Francisco State Col.	Phys. Sci.	Psych.					Graduate courses in education-Stanford
034	63	Univ. of Calif-Berkeley	Elect. Engr.		67	San Jose State Col.	Elect. Engr.		
035	68	Univ. of Texas-Austin	Chem. Engr.	Math					Teaching credential in adult education, Math

TABLE 6; -cont.-

CODE NO.	BACHELOR'S DEGREE: DATE BA/BS	WHERE ATTENDED	MAJOR	MINOR	MASTER'S DEGREE: DATE MA/MS	WHERE ATTENDED	MAJOR	MINOR	OTHER EDUCATIONAL EXPERIENCES
036	69 73	Centro Escolar Univ. (Philippines)	Pre-med chem	Chem math					Fruit & vegetable preservation; spectro-photometry
037	69	Mapan Inst. of Tech (Philippines)	Chem Engr.	Chem					Drafting
038	72	Arizona State Univ.	Engr. Sci.	Pre-med					Auto repair
039	67	Univ. of Kansas	Elec. Engr./ Math						
040	56	Rutger's University	Physics		68	Catholic Univ.	Physics		

***Code No. 006: 1968 Ph.D. from University of California - Berkeley in Library Sciences

Educational Factors
by Persistance

	Foreign Degrees	Degrees in Engineering	Masters Degrees
Completed Program N = 28	14% (N = 4)	11% (N = 3)	31% (N = 8)
Dropped Out N = 12	33% (N = 4)	41% (N = 5)	16.7% (N = 2)

The dropouts were much more likely to hold engineering degrees and to have degrees from outside the United States. They were much less likely to have earned an advanced degree.

Table 7 shows the participants's employment history. All of the women on whom we have data indicated that they have held at least one job since earning their last degree. Of course, many of these positions were not science related. The average number of years not in a science career ranges from 0 to 20 years, with an average of 5.8 years. Those who completed the program were likely to have been away from sciences slightly longer (6.1 years) than those who dropped out (5.3 years).

Table 8 presents Personal Data on the participants. The breakdown of marital status is as follows:

Marital Status

	Married	Single	Divorced or Separated
Completed Program (N = 28)	N = 14	N = 9	N = 5
Dropped Out (N = 12)	N = 8	N = 3	N = 1
TOTAL (N = 40)	N = 22 52.5%	N = 12 30%	N = 6 12.5%

Exactly half of the total group had children (N = 20). Those who completed the program had a slightly higher average number of children (2.25 children per participant vs. 1.9 children per participant who dropped out).

The ethnic breakdown of the group is as follows:

Ethnic Backgrounds

Caucasian	27 (68%)
Asian	10 (25%)
Chicana	1 (2.5%)
Black	0 (0%)
No data	2 (5%)

TABLE 7: EMPLOYMENT DATA BY PARTICIPANT

CODE NO.	PAID POSITIONS SINCE LAST DEGREE	UNPAID VOLUNTEER WORK	YEARS NOT IN SCIENCE CAREER	REASONS FOR NOT BEING IN SCI. CAREER
001	U.S. Geological Survey: Chemist/Research Tech.	- - - -	0	NA
002	Philippines: 1. Research Asst. 2. Inventory Control 3. Supvr. Prod. Planning & Inventory Control U.S.A.: 1. Macy's Sales Audit Clerk 2. Chemist	- - - -	6	Job availability (foreign degree)
003	Teacher: 4th grade, H.S., Jr. Hi, substitution	- - - -	11	Unclear of what she could do; more interested in marriage.
004	1.Bindery Assistant 2.Sr. Insurance Underwriter	- - - -	6	Job availability; became caught up in other jobs.
005	Improved Manufacturing Methods	- - - -	8mo.	Co. moved to new city; foreign degree; lang. probl.
006	Egypt: Nuclear engineer U.S.A.: Research Asst.	- - - -	8	No jobs available for a woman eng., especially with a foreign degree
007	Math & Physics Teacher	- - - -	7	No jobs available
008	(NO DATA)			
009	1.Secondary Math Teacher 2.Part-time secretarial & data processing work	- - - -	6	No marketable skills related to science
010	1.Mgr., U.C. Law School Admissions Office 2.Circ. Supvr. UC Library 3.E.S.L. Instructor 4.Clerk	- - - -	Never in one	Inadequate preparation
011	Japanese instructor	- - - -	Never in one	No marketable skills
012	Typist Clerk	- - - -	4	No B.S. in Chem. and no money to go back to school.
013	1.Legal Assistant 2.Epidemiologist 3.Pension Clerk	Planned Parenthood Worker	3	No marketable skills

TABLE 7: -cont.-

CODE NO.	PAID POSITIONS SINCE LAST DEGREE	UNPAID VOLUNTEER WORK	YEARS NOT IN SCIENCE CAREER	REASONS FOR NOT BEING IN SCI. CAREER
014	Teacher of Math	- - - -	0	(She considers teaching a science career)
015	Special Asst. Engineer	- - - -	20	Family; no jobs available
016	1. Data processor 2. Geometry tutor	- - - -	1	No jobs available
017	1. Secretary 2. Teacher's Asst. 3. Applied Math. Res.	1. Drug Facility supvr. & counselor 2. Fund raising	20	Commitment to family, & volunteer activity
018	1. Tax preparation 2. Detergent Lab. Res. 3. Chemist	- - - -	16	Family responsibilities
019	Math Teacher	- - - -	10	(She considers teaching a science career)
020	1. Teacher 2. Office work 3. Training for Peace Corp. 4. Resource teacher	- - - -	10½	No marketable skills; no job experience
021	1. Fish & Game Lab. Tech. 2. Camp couselor 3. Research Asst. in Envir. Studies 4. Studied Envir. Inpact Statements	- - - -	1	Lack of confidence
022	1. Nun 2. Math teacher	- - - -	5½	Family responsibilities
023	(NO DATA)			
024	Teacher	- - - -	3	(She considers teaching to be a science career)
025	1. Teacher (½ time) 2. Design Draftsman	Girl Scout Leader & Trainer, etc.	9	No jobs available; 1968 layoff
026	Liquid Crystal Jr. Technician	- - - -	6 mo	Vietnamese refugee
027	1. H.S. & Comm. College Teacher 2. Income tax preparation	- - - -	2	Unequal pay for women, so went into teaching

TABLE 7: -cont.-

CODE NO.	PAID POSITIONS SINCE LAST DEGREE	UNPAID VOLUNTEER WORK	YEARS NOT IN SCIENCE CAREER	REASONS FOR NOT BEING IN SCI. CAREER
028	1. Medical Chemist 2. Public Health Chemist	- - - -	0	NA
029	Statistical clerk	- - - -	2	Job availability foreign degree
030	Chemical analysis of food	- - - -	2 mo.	"to look for work"
031	1. H.S. Math/Sci Teacher 2. Forensic Chemist	- - - -	11 mo.	No US experiences No contacts with employers
032	1. Statistician 2. Programmer 3. Programmer Analyst 4. Systems analyst	- - - -	1	1. moved out of state 2. Pre-school child 3. Lack of jobs in specific area.
033	1. Sort Mart 2. Own business 3. Library clerk	- - - -	9	No marketable skills
034	Testing	- - - -	11	Raising 3 children
035	1. Physics lab tech. 2. Chem lab tech. 3. Sciences tutor	- - - -	17	Raising 4 children
036	Chemist	- - - -	1	Nursed sick parents
037	1. Lab assistant 2. Lab tech. 3. Assembler	- - - -	3	1. foreign degree 2. Lacks local experience
038	1. Chem. Lab. Tech. 2. Literature researcher 3. Engr. tech. to manager	- - - -	9 mo.	Resolving personal problems
039	1. Xerox machines operator 2. Psychiatric Counselor 3. Teacher 4. Ran small business	- - - -	8½	1. No science jobs available when graduated. 2. Lack of confidence
040	Prof. of Freshman Physics	- - - -	9	Discrimination

TABLE 8. PERSONAL DATA BY PARTICIPANT

CODE NO.	SOCIAL SECURITY NUMBER	RACE/ ETHNIC BACK.	MARITAL STATUS	CHILDREN NO. CHILDREN	CHILDREN NO. AT HOME	CHILD CARE ARRANGE.	COST	HUSBAND'S OCC. IF MARRIED	SOURCES OF FINANCIAL SUPPORT
001	554-94-5316	CAUC.	S	0	NA	NA	NA	NA	B, E, H
002	567-90-1236	ASIAN	S	0	NA	NA	NA	NA	C, E
003	056-36-2056	CAUC.	M	2	2	HUSBAND	0	TEACHER	A, C
004	549-76-0848	CAUC	S	0	NA	NA	NA	NA	C
005	565-84-2927	ASIAN	M	0	NA	NA	NA	Wife: NURSE	C
006	549-96-4795	EGYPTIAN	DIV.	2	2	TOOK CARE OF SELVES	0	NA	G
007	569-78-4188	- - - -	M	0	NA	NA	NA	H.S. TEACHER	A, B
008	- - - - - -	CAUC.	M	1	1	HUSBAND	0	PROGRAMMER	A, B
009	354-34-4827	CAUC.	M	0	NA	NA	NA	COMP. PROGRAMMER	A, B, C
010	572-98-8364	CUAC.	S	NA	NA	NA	NA	NA	C
011	547-86-5505	ASIAN	M	2	2	HUSBAND	0	ATTORNEY	A, B
012	549-68-4214	CHICANA	S*	0	NA	NA	NA	NA*	A*, B, C, H
013	009-32-8467	CAUC.	S	NA	NA	NA	NA	NA	
014	209-30-2941	CAUC.	M	0	NA	NA	NA	TEACHER	A, C, H
015	430-44-8476	CAUC.	M	4	3	HUSBAND/OLDER DAUGH.	0	TELEPHONE ENG.	A, K (inheritance)
016	565-88-4209	CAUC.	S	0	NA	NA	NA	NA	B, E, H

*To be married 7-15-78
Husband: Chemist/Ind. Hygienist

TABLE 8. PERSONAL DATA BY PARTICIPANT
Page - 2 -

CODE NO.	SOCIAL SECURITY NUMBER	RACE/ ETHNIC BACK	MARITAL STATUS	CHILDREN NO. CHILDREN	CHILDREN NO. AT HOME	CHILD CARE ARRANGE.	COST	HUSBAND'S OCC. IF MARRIED	SOURCES OF FINANCIAL SUPPORT
017	568-42-1336	CAUC.	M	2	1	HUSBAND/GRANDPARENTS	0	CHEMIST	A, K (Personal investment inc)
018	327-28-6826	CAUC.	DIV.	3	3	GRANDPARENTS/SELVES	0	NA	B, C
019	563-54-1280	CAUC.	SEP.	3	3	FORMER HUSBAND/ AUNT/SELVES	0	NA	C, K (Child support; interest on loan)
020	521-56-0245	CAUC.	S	0	NA	NA	NA	NA	B
021	212-50-2333	CAUC.	S	0	NA	NA	NA	NA	B, C, E, H
022	335-30-5910	CAUC	M	2	2	HUSBAND	0	TEACHER	A, C, H
023	556-74-7116	- - -	M	0	NA	NA	NA	- - - -	H
024	563-50-7213	CAUC.	M	2	2	SELVES	0	SALESMAN	A, C
025	- - - - - -	CAUC.	M	2	2	HUSBAND/SELVES	0	POLICE ADMINISTRATOR	A, B, C, H
026	586-44-5669	ASIAN	M	0	NA	NA	NA	ELECTRONIC TECH.	A, C
027	521-40-1188	CAUC.	DIV.	2	2	SELVES	0	NA	H
028	561-40-2977	CAUC.	DIV.	0	NA	NA	NA	NA	C
029	555-33-4966	ASIAN	M	1	1	MOTHER-LAW/HUSBAND	0	ELECTRICIAN/ DIESEL MECHANIC	A, C
030	572-86-4693	ASIAN	M	1**	**	**born during program -left program	- -	MAIL CARRIER	A, C
031	558-45-0531	ASIAN	M	2	2	MOTHER/HUSBAND	0	UNEMPLOYED	(UNKNOWN)
032	517-48-0650	CAUC.	M	2	2	PARENTS	0	NEWSPAPER REPORTER	A
033	548-66-7537	CAUC.	M	1	1	HUSBAND	0	UNEMPLOYED	(UNKNOWN)

TABLE 8. PERSONAL DATA BY PARTICIPANT
Page - 3 -

CODE NO.	SOCIAL SECURITY NUMBER	RACE/ ETHNIC BACK	MARITAL STATUS	CHILDREN NO. CHILDREN	CHILDREN NO. AT HOME	CHILD CARE ARRANGE.	COST	HUSBAND'S OCC. IF MARRIED	SOURCES OF FINANCIAL SUPPORT
034	567-50-7659	ASIAN	M	3	3	GRANDMA	0	ELECTRICAL ENG.	A, B
035	140-24-9897	CAUC.	DIV.	4	1	NA	0	NA	B
036	561-45-3602	ASIAN	S	0	NA	NA	NA	NA	(UNKNOWN)
037	486-72-5037	ASIAN	M	1	1	BABYSITTER	UNK.	CLIN. LAB. TECH.	A
038	526-76-1383	CAUC.	S	0	NA	NA	NA	NA	C
039	497-38-4456	CAUC.	S	0	NA	NA	NA	NA	C
040	208-12-7293	CAUC.	M	0	NA	NA	NA	(UNKNOWN)	(UNKNOWN)

KEY: SOURCES OF FINANCIAL SUPPORT

A - HUSBAND
B - CO-OP JOB
C - OTHER JOB (YOURS)
D - WELFARE
E - RELATIVES/FRIENDS
F - SCHOLARSHIP
G - ALIMONY/SPOUSAL SUPPORT
H - SAVINGS
I - LOAN - STUDENT
K - OTHER

V. GENERAL INFORMATION

A. Promotion

The Women in Engineering Program was designed to accommodate 20-40 participa nts who needed to have a science degree but be unemployed or "under-employed." Almost no information was available on how large this target population might be in the greater Bay Area or on how these women might be reached. Because of the format, both working and non-working people were candidates.

It was decided to attack the promotion problem from a variety of angles.

Four prime promotion pieces were designed: (1) a news release, (2) a display ad for Extension and alumni bulletins, (3) a brochure, and (4) a commercial advertisement. Work on the brochure was held up for several months while project staff and University administrators debated the issue of whether applications from men would be considered. After much discussion with the National Science Foundation, the project staff and the University of California administration, the decision was made that it would be ill-advised to exclude men; therefore the brochure was revised to include the following statement: "This re-entry program is designed primarily for women, but is open to all qualified applicants."

The project's promotional activities included:

1. Direct mailing of brochures to women on alumni mailing lists from cooperating universities. It turned out difficult to obtain such mailing lists.
2. News releases were sent to:
   - Society of Women Engineers
   - American Society for Engineering Education
   - U.C. Alumni bulletins
   - Women's Caucuses
   - American Association of University Women
   - Newspapers in the western U.S.
   - Local women's centers
   - Engineering deans at California colleges and universities

3. Joint promotion with the NSF programs at the University of Dayton and Notre Dame University.
4. The course offering was listed in U.C. Extension bulletins.
5. Personal contact by the Program Coordinator at:
   Summer 1976 American Society for Engineering Education Conference
   Meetings of Bay Area Society of Women Engineers
   Meetings of Golden Gate section of S.W.E.
6. Newspaper ads placed in San Francisco, Oakland, and San Jose newspapers

All these activities would be useful in an on-going program, but the most effective approach for this start-up program was the use of paid newspaper advertisements. While expensive, the ads brought immediate and dramatic response from interested women.

V. B. Selection

All candidates were required to submit an application form (enclosed), college transcripts, and answers to the following question:

Application/Questionnaire

1. What is the length of time and the periods during which you were not is a science or science-related career?
2. What are your reasons for not being in a science or science-related career?
3. What is your current career goal?
4. Why did you apply to participate in this project?
5. What do you expect to get out of participation in this project?

Materials were due April 1, 1977. Eighty-eight completed applications were received by that date and were considered by a selection committee consisting of:

Donna S. Frohreich (Chair), Project Coordinator
Gary Pastre, IBM, San Jose
Helen Joyce Peters, Department of Water Resources, Sacramento

The committee members received and reviewed copies of all application materials individually and then met to make the final selections.

Upon the recommendation of the Advisory Committee, the following factors were considered in the selection process:

a) Bachelor's degree in science earned between 1961 and 1974
b) Four semesters of college level mathematics including differential equations
c) One semester of college level physics
d) One semester of college level chemistry
e) College grades
f) Work experience
g) Indications of interest in science, such as having taken continuing education courses in technical areas

APPLICATION FORM

UNIVERSITY OF CALIFORNIA — DAVIS
and the
National Science Foundation
Career Facilitation Training for Women

Name _____ Social Security _____/_____/_____

Place of Birth _____ Date of Birth _____

Permanent Address _____ Phone (_____) _____

City _____ State _____ Zip _____

EDUCATIONAL RECORD

College or University Name, City and State	Degree Earned	Date of Graduation	Major Program or Study	Minor Programs or Study

List and briefly describe other education experiences, including formal and informal training, since obtaining last degree:

EMPLOYMENT RECORD

Employer or Volunteer Agency Since Last Degree: Name and Address	Brief Description of Job or Activity	Dates of Employment or Volunteer Activities	Check if: Paid Position	Unpaid Volunteer Work

Please answer questions 1-5 on the reverse side of this form on a separate piece of paper.

Applicants were not asked to give personal interviews because of restrictions on staff time and because regular applicants to the University of California are not interviewed as part of the selection process. Scores on the Graduate Records Examination were also not required. It was felt that such information would not aid in selecting appropriate participants since re-entry students would have widely divergent scores. One of the objectives of the program was to give participants an intensive math review.

Results of the Selection Process

88	Completed applications received as of April 1, 1977
1	Withdrawal before selection was completed
87	Considered for selection (including 2 men)
58 (66%)	Offered admission (including 1 man)
	14 (or 24%) were applicants with degrees from outside the U.S.
9 (16%)	Declined offers of admission (including 3 non-U.S. degree holders)
9 (16%)	Withdrew (including 2 non-U.S. degree holders)
40	Attended the summer session. These 40 were defined as the "participants". (Includes 1 male; 9 with degrees from outside the U.S.)
10 (25%)	Dropped out as of March, 1978
2 (5%)	Additional drop-outs
28	Received Certificates of Completion

Problems in Selection

Basically the selection procedure went extremely well. A few mechanical problems slowed the process down a bit: college transcripts arrived frequently in the woman's maiden name and we had difficulty identifying

to whom they belonged. It was difficult to distill the relevant academic information directly from transcripts which were often hard to read and which used different terminology for the same courses. Many applicants did not type their forms thereby making them especially hard to read and to copy.

Information about those who were chosen is offered in the "Applicant Data" section.

V. C. Evaluation

An ambitious evaluation plan was developed by the program's evaluation consultant, but due to time and staff limitations the actual evaluation had to be greatly reduced.

Participants were asked to evaluate the initial summer session and to give details of their backgrounds and their expectations about the program. Part of this evaluation included their attitudes about women in careers and about the field of engineering.

Toward the middle of the program students who had taken co-op positions were asked to make a brief report on their jobs. If time had allowed, it would have been desirable to have requested evaluations of the students by their employers, as is usually done with co-op students.

During the final summer session participants were asked to give an overall evaluation of the program, as well as to re-take the attitude surveys to see if there had been any shift in attitudes during the year. During the summer session, the students met informally with the Project Director and the Coordinator to give more exhaustive feedback about the program.

In the original grant proposal the amount of staff time and the financial resources needed to carry out an effective evaluation process were greatly underestimated. The staffing changes in the 1978-79 program should ameliorate this problem for the coming year.

NATIONAL SCIENCE FOUNDATION

WOMEN IN SCIENCE : SCIENCE CAREER FACILITATION

UNIVERSITY OF CALIFORNIA, DAVIS WOMEN IN ENGINEERING PROGRAM

EVALUATION/REPORTING TASKS AND TIMELINE
July 1, 1977 - June 30, 1978

Prepared by Stephanie Twomey
Evaluation Consultant

TASK	WORK SCHEDULE: DUE DATES
A. Evaluation of Recruitment Process	
1. Develop questionnaire for applicants who were not selected.	July 13-29, 1977
2. Develop questionnaire for applicants who were selected but did not participate.	July 13-29, 1977
3. Mail questionnaires.	August 1, 1977
4. Follow-up on no responses.	August 22 - September 2, 197
5. Tabulate information.	September 3-5, 1977
6. Analyze returns/tabulations for future use.	September 8-9, 1977
7. UCD Promotional Department develops graphs and charts for presentations.	September 12-16, 1977
8. Develop and mail in June, 1978 a second short questionnaire or post card to same people for final information.	May 15-June 1, 1978
9. Include results in Interim and Final Reports.	February 1 and August 1, 1978

B. Evaluation of Two-Week Summer Session

1.	Develop simple instrumentation to measure participants' opinions of each of the summer session's components, including the recruitment process.	July 19-20, 1977
2.	Participants evaluate two-week session.	July 23, 1977
3.	Analyze participants' academic achievement in two-week session using grades as indicators.	August 1, 1977
4.	Evaluate the two-week session from the professors' points of view.	July 23, 1977

C. Evaluation of Participant Attitude Toward Successful Careering in Engineering

1.	Develop a questionnaire for participants on attitudes about women's careering in science and on other affective areas relating to professional women and/or adapt the Purdue Survey.	July 15-20, 1977
2.	Administer questionnaire, with modifications, three times to monitor changes in atitude at critical points in the program.	July 23, 1977 December 10, 1977 June 1, 1978
3.	Include preliminary results in Interim Report.	February 1, 1978
4.	Analyze personal journals submitted once a month.	June 1-July 1, 1978
5.	Analyze results, compare to Purdue results, have Promotional Department draw up charts and graphs, and include results and analyses in Final Report.	June 15-July 15, 1978

SCT: 7/15/77

D. Evaluation of Cooperative Job Placement

1. Identify the number of participants who wanted the coop experience either semester and those who actually took jobs.	March 1, 1978
2. Take standard coop evaluation used nationally and modify appropriately.	September 1-30, 1977
3. Use modified instrument to survey both participants and employers.	January 15 and May 30, 1978
4. Compare the persistance of coop and non-coop participants in the program to see if this component seems to have an effect on program success.	June 1, 1978
5. Analyze results, compare to others if available, have Promotional Department draw up charts and graphs, and include results in Final Report.	June 1-15, 1978

E. Evaluation of the Academic Experience and Preparation of Participants

1. Obtain participants' assessments of coursework as part of the questionnaire in (C) to be administered in December and June.	December 10, 1977 and June 1, 1978
2. Obtain subjective assessments of professors on how they think participants compare to regular EE students. Notify them at the beginning of the term so they can more adequately prepare their justifications.	
• Notification	September 1, 1977 and January 15, 1978
• Subjective Assessment	December 15, 1977 and May 25, 1978
3. List participants' summer projects with statements of professors' reactions.	July 10-15, 1978
4. Analyze selected course final exam results of participants and compare to UCD and/or UCB EE students.	July 15-20, 1978
5. Compare participants' results on the Engineering In Training Exam (EIT) with other known results.	Spring, 1978
6. If resources permit, invite EE professors from Stanford, Berkeley, etc. to conduct on-site evaluation of particpants' training.	April 1-May 1, 1978
7. Analyze results, have Promotional Department draw up charts and graphs, and include results in Final Report.	July 15-30, 1978

F. Overall Evaluation of Training Results

1. Use simple survey and analyze the post-training results for those finding employment: — July 1-10, 1978

   - Number employed full or part time.
   - Salaries and job titles of those employed.
   - Compare actual salaries to participants' own estimates in the beginning of the program.

2. Use simple survey and analyze the post-training results for those seeking further training. — July 1-10, 1978

   - To what graduate schools did participants apply.
   - For what reasons did participants decide on further training.

3. Examine the employment process for EE's to determine if women's experiences are similar to those of others. — July 10-20, 1978

   - Compare post-training results to those of other graduating EE classes nationwide (i.e. BS with no experience) by discipline and by employer.
   - Compare participants' experiences to those of Davis and/or Berkeley EE graduates.
   - Compare participants' results to salary data in the Endicott Report.
   - Compare participants' results to reported results of non-participants and drop outs from the program.

4. Analyze results, compare to available data, have Promotional Department draw up charts and graphs, and include results and analyses in Final Report. — July 20-30, 1978

FINAL REPORT - EXAMINATION DRAFT	August 1-15, 1978
FINAL REPORT - FINAL COPY	August 15-20, 1978
DUPLICATION OF REPORT	August 20-30, 1978
MAIL	September 1, 1978

SCT: 7/15/77

V. D. COST DATA

The University of California, Davis, Women in Engineering Program was one of the least costly of the NSF Career Facilitation Projects and one of the most cost efficient. The federal funds allocated totalled $64,531.00 for the training of the 40 participants - or $1,613.28 per person who entered the program.

The total cost of the project is broken down as follows:

$64,531	NSF grant
10,000	Grantee institution (estimated)
5,000	Donated services (estimated) (includes time of Advisory Committee, speakers, tours, etc.)
30,000	Students costs (including books, weekend commuting, room & board for two summer sessions)
$109,531	or $2,738 per participant

Using these estimates, the NSF grant accounts for approximately 60% of the total program costs.

V. E. Effectiveness of Program Components

The original design for the Women in Engineering Program was well-thought-out and contained a number of important, integrated elements. As a result, the relative effectives of various components is difficult to determine. There were no aspects of the program which were failures - the continuation program 1978-79 has made only small modifications of the original plan. If it is necessary to name components which were not as effective as anticipated in helping to meet Project objectives, perhaps two things could be mentioned: (1) Because of the other placement oriented activities, the Placement Brochure was not as necessary as expected in helping students get permanent jobs. It was clearly very useful and did result in many contacts, but students did use other approaches, too. (2) Summer Session II (June 25-July 8, 1978) offered an excellent course in Instrument Design, but since most of the participants who wanted engineering jobs already had them by that time, the summer course contributed less than expected toward their job placement.

On the positive side, many elements were potent contributors to the overall success of the project. If it had to be narrowed down to three, the following were probably the most important: (1) Summer Session I was vital. During that time the bulk of the refresher work in physics, computers and mathematics was accomplished and without that background few if any of the participants could have succeeded in the engineering courses which followed. The summer session was also important as a means of establishing group cohesiveness and of laying the foundation of the support and professional development activities. (2) The 8 core courses were vital to achieving the objective of making participants immediately employable as engineers. Math provided the foundation for the engineering courses. The Circuits, Statics, and Materials courses gave students a solid foundation in engineering fundamentals. The last four electrical engineering classes were vital in giving students the specialized electronic engineering courses which employers were looking for. (3) The third essential program component was the support and professional development element which has been described above.

Since the women were under considerable stress and since few of them had had any previous exposure to engineering as a career opportunity for women, it is doubtful that many would have completed the program without these support activities.

VI. A. 2. Graduate School

Preparing women for success in graduate studies in engineering was a secondary objective of the project. Only two women originally expressed a desire to attend graduate school full-time and both were accepted to graduate programs in engineering - - one at University of California - Davis and one at Stanford University. The second student ultimately decided to attend Stanford part-time while she worked at an engineering job. A third student plans to attend graduate school in psychology.

Throughout the year, the importance of continuing education was stressed again and again. Because of the emphasis placed on it and because of the easy availability of good graduate programs in engineering and management, it is probable that a large proportion of the participants will continue their engineering studies on a part-time basis while working.

VI. A. 3. Personal Development

When they began the NSF Women in Engineering Program, most of the women were quite single-minded about what they wanted to get out of the program. They wanted to get training so that they would be hired as engineers. Few mentioned expecting anything which might be described as personal development. Yet when they completed the year's experience, in addition to the training they had originally desired, many participants listed personal development items as important benefits of the program.

The two most frequently mentioned were significantly increased self-confidence and an enlarged circle of good friends. Both of these results were utterly apparent to staff and friends who had seen the women at the beginning and at the end of the project.

Below are a few of the womens' own comments about the extra-professional benefits of their year's experience:

"...Better self-esteem, more friends,...do more in alloted time."

" A hell of a lot of confidence... 20 plus good friends...three gray hairs."

" I have found a whole new range of learning capabilities in myself - also a whole new spectrum of pleasure in study..."

"...Renewed enthusiasm for other women...improved self-image."

" Personal growth and self-confidence...the association with a fine group of women, all of whom reinforced my feelings about the capabilities of women in the technical field."

" This program has given me the opportunity to re-evaluate my abilities and my interests."

" An increased feeling of self-worth. Good friends."

" The opportunity to share my career interests with other women - for the first time in my life!"

" Confidence in my abilities; friends I'll never forget; enthusiasm for further studies; depth of understanding in scientific subject matter are my gains. The worth of the program to me, personally, is beyond articulation for the feelings I retain. By the other women I was intellectually outclassed but not outcast - - consoled not competed with - - accepted never alienated and by all, in all ways, treated with the dignity and respect accorded worthy individuals. This treatment has improved my self-image. I am grateful for everything except the weight I gained!"

VI. OUTCOMES

A. Participant Outcomes

1. Employment

The prime objective of the NSF Women in Engineering Program was to prepare women for employment in engineering at a level comparable to current B.S. graduates. While all the data are not yet available, it appears that this objective was successfully achieved. Table 9 lists the Current Employment information for each participant. To summarize the status of the group who completed the program as of the end of summer 1978:

Figure VI.1

Employment Status
(as of August 1978)

Employed -		
Engineering	18	64%
Non-engineering	2	7%
Graduate School full time	2	14%
Seeking Employment	4	14%
Not Actively Seeking Empl.	1	2.5%
Unknown	1	2.5%

Several of those who are listed as "seeking employment" planned to vacation before actively looking for engineering jobs.

Below is a list of the engineering employers of the program's graduates:

Bechtel Corp.
Environmental Research & Technology
Ford Aerospace & Communications
Glidden Paints

Hewlett-Packard - Data Systems
IBM - General Products Division (4 participants)
ITEL
John Deere Tractor
Kentron International, Inc.

Linkabit Corp
School of Information Studies - Syracuse University
Texas Instruments

Before turning to current salaries, it is interesting to note the students' pre-program annual earnings (1976-77), and compare those who stayed in the program with those who dropped out:

Figure VI.2
1976-77 Earnings

	Completed Program N = 28	Dropped Out N = 12
Average Earnings	$6,276	$1,673
Number Unemployed in 1977	6	8
Percent Unemployed	23%	73%

Fifty-seven percent of those who were unemployed immediately before beginning the program later dropped out (that is, 8 of 14).

Only 15% of those who were working at the start of the program dropped out (4 of 26). Immediate past employment status would seem to be one good prediction of persistance in this program. (See Table 10).

The average engineering salaries accepted by NSF Women in Engineering participants is $18,341. This is $1,661 higher than the average starting salary of $16,680 per year projected for students graduating with B.S. degrees in engineering in 1978 (source: Frank Endecott, Northwestern University). Clearly the women did take positions comparable to new graduates.

The increase in income for those who took engineering positions is most impressive = $10,320 per year per participant. Such an increase in a one year period is most remarkable. (See Figure VI.3)

Figure VI.3
Current Engineering Salaries*
(As of August 1978)

Less than $16,000	$19,000
$13,000 (plus room & board)	$19,000
$15,600 (9 months)	19,000
	19,000

$16,000	More than $20,000
$16,000	$23,000
16,500	23,000

$17,000
$17,400

$18,000
$18,300
18,600
18,600
18,900

Average Engineering Salary for Group = $18,341

Average Projected Starting Salary for B.S. Engineering Students (Source: Frank Endecott, Northwestern) in 1978 = $16,680

Range of NSF Group's Salaries = $13,000 to $23,000

* Does not include those unemployed or employed in non-engineering jobs.

TABLE 9: CURRENT EMPLOYMENT

CODE NO.	PRE-PROJECT INDIV. INCOME (1976-77)	EMPLOYER OR GRADUATE SCHOOL AS OF AUGUST 1978	POST-PROJECT INDIV. INCOME (1978-79)	CHANGE IN INDIV. INCOME
001	$9,000	IBM General Prod. Division-San Jose,CA	$17,400	$8,400
002	15,000	Glidden -SCM- San Francisco, CA	23,000	8,000
003	8,000	S.F. Unified School District	8,000*	0*
004	10,000	John Deere Tractor - Iowa	18,300	2,300
005	0	Unknown but is employed	(unknown)	- - - -
006	0	School of Information Studies - Syracuse Univ. - Syracuse, N.Y.	15,600 (9-mo.)	15,600
007	0	Texas Instruments - Dallas, TX	18,600	18,600
008	0	Ford Aerospace & Co. - Palo Alto, CA	18,900	18,900
009	10,000	IBM - General Prod. Division -Los Gatos, CA	19,000	9,000
010	10,800	- - - -	- - - -	- - - -
011	2,000	Bechtel Corp - San Francisco, CA	16,200	14,200
012	12,000	Getting married, then will look for job	- - - -	- - - -
013	6,500	Traveling after program	- - - -	- - - -
014	14,500	All Saints Day School, Carmel Valley, CA	16,000*	1,600*
015	0	Not actively seeking employment	- - - -	- - - -

TABLE 9: CURRENT EMPLOYMENT

CODE NO.	PRE-PROJECT INDIV. INCOME (1976-77)	EMPLOYER OR GRADUATE SCHOOL AS OF AUGUST 1978	POST-PROJECT INDIV. INCOME (1978-79)	CHANGE IN INDIV. INCOME
016	2,000	Kentron Int'l Inc. Marshal Islands	13,000	11,000
017	0	(Graduate School in Psychology)	- - - -	- - - -
018	8,300	Linkabit - San Diego, CA	16,500	8,200
019	13,000			
020	15,500	IBM Data Prod. Division - Santa Teresia, CA	19,680	4,180
021	2,000	ITEL, Sunnyvale, CA	(unknown)	- - - -
022	10,000	- - - -	- - - -	- - - -
023	"Personal"	Graduate student Univ.of Cal-Davis	na	na
024	8,850	Hewlett-Packard-Cupertino, CA	23,000	14,150
025	6,000	General Electric - Sunnyvale, CA	19,000	13,000
026	10,200	Unknown	(unknown)	- - - -
027	19,650	IBM General Prod. Division-San Jose, CA	18,600	-1,050
028	19,980	Environmental Res. & Tech.-Westlake Valley, CA	(unknown)	- - - -
029	0	unknown	unknown	- - - -
030	10,000	unknown	unknown	- - - -

TABLE 9: CURRENT EMPLOYMENT

CODE NO.	PRE-PROJECT INDIV. INCOME (1976-77)	EMPLOYER OR GRADUATE SCHOOL AS OF AUGUST 1978	POST-PROJECT INDIV. INCOME (1978-79)	CHANGE IN INDIV. INCOME
031	0	unknown	unknown	- - - -
032	0	Four Phase - San Jose, CA	unknown	- - - -
033	0	United Technologies - Sunnyvale, CA	unknown	- - - -
034	0	IBM General Prod. Division-San Jose, CA	unknown	- - - -
035	0	Fairchild Semiconductor	unknown	- - - -
036	0	unknown	unknown	- - - -
037	0	unknown	unknown	- - - -
038	3,600	unknown	unknown	- - - -
039	4,800	unknown	unknown	- - - -
040	unknown	unknown	unknown	- - - -

* not engineering related

TABLE 10

PROJECTED 1978 JOB OUTLOOK

Recruiting Activity
Graduates with Bachelor's Degrees

	Class of '77		Class of '78	
	Companies Recruiting	Graduates Hired	Companies Recruiting	Graduates To Be Hired
ENGINEERING	118	5,122	123	6,299
ACCOUNTING	102	4,019	101	4,410
SALES, MARKETING	77	1,799	85	1,929
BUSINESS ADMINISTRATION	88	1,633	92	1,774
LIBERAL ARTS	56	1,001	53	1,016
CHEMISTRY	40	323	41	377
MATHEMATICS, STATISTICS	43	284	40	359
ECONOMICS, FINANCE	34	328	30	347
COMPUTER SCIENCE	65	638	65	815
OTHER FIELDS	41	411	36	421
TOTALS		15,558		17,747

Projected Starting Pay
for 1978 Bachelor Degree Graduates

	$1,000 or less	$1,001 to $1,100	$1,101 to $1,200	$1,201 to $1300	$1,300 or More	Average Starting Salary
ENGINEERING	----	10	114	962	5,213	$1,390
CHEMISTRY	47	55	81	103	91	$1,225
COMPUTER SCIENCE	110	105	204	206	190	$1,180
OTHER FIELDS	90	160	38	26	107	$1,154
MATHEMATICS, STATISTICS	39	68	102	129	21	$1,136
ACCOUNTING	80	363	3,865	92	10	$1,122
SALES, MARKETING	713	529	461	226	----	$1,053
ECONOMICS, FINANCE	157	135	32	23	----	$1,006
BUSINESS ADMINISTRATION	862	411	399	102	----	$1,004
LIBERAL ARTS	673	152	139	42	----	$ 950

Source: Frank S. Endicott, Northwestern University
Based on report by 183 companies.

VI. B. Effects of Project on University of California - Davis

The Women in Engineering Program has received a continuation grant from the National Science Foundation and is already currently underway. The new program is being conducted from July 1978 through July 1979, with several months to follow for evaluation and reporting. Very few modifications were made in the new program. A 3/4 time Project Coordinator, Elizabeth Busick, has been hired and the project continues under the direction of Dr. Richard Dorf as Project Director. There has been a slight alteration in the scheduling of some of the weekend courses and there has been some relatively minor revision in the content of two courses. In all essential aspects, the new program is the same as the one done in 1977-78.

The effects of the Women in Engineering Program on the grantee institution, the University of California, Davis, must be presented within the framework of the conditions which existed at the University before the project began: (1) the College of Engineering at Davis enrolled more women engineers than any other school in California; (2) the University Extension had a long history of professional development programs for adult students; (3) the University and the University Extension had active programs for women.

The effect of the project on University staff has been largely limited to changing the attitude of the Dean of Engineering and other engineering faculty from one of neutrality regarding the probability of the program's succeeding to a positive belief that if properly funded, the Women in Engineering Program can serve as an effective re-entry mechanism for mature women who intend to work as engineers.

The faculty who were involved as instructors are now much better informed about the capacities of re-entry women and they seem to be enthusiastic supports of the efforts, as evidenced by the fact that all the original faculty were willing to participate again in the 1978-79

program.

Few special teaching materials or techniques were devised for the Women in Engineering Program. The two summer sessions plus 26 weekend session format, however, was a unique aspect of the program and will be used for other re-entry programs offered by the University Extension.

VI. C. Effects of Project on Other Institutions

Until the dissemination portion of the project is completed, it is not possible to know whether other institutions will be willing to adapt the program for use in their own geographical areas. It is to be hoped that a program with a proven record of success will be enthusiastically embraced by other universities. Logical target areas might include:

Los Angeles, California
Dallas/Fort Worth, Texas
Chicago, Illinois
Boston, Massachusetts
New York, New York
Detroit, Michigan

These are all geographical locations with large populations, with thriving high technology industry, and with a group of universities with engineering facilities. Electrical engineering might not be the appropriate subject matter in a program in all these locations, but the curriculum could be modified to focus on mechanical or chemical engineering.

The main effect of the UCD program has probably been on the engineering companies which have been involved. They now understand that re-entry women can be an excellent source of engineering talent. The companies are now much more willing to cooperate with the program by offering cooperative education jobs and by expressing a desire to employ future program graduates.

VI. D. Benefit to the Federal Government

Many federal grants produce little direct financial benefit to the government - or if there is a benefit, it accrues only over a very long period of time. The UCD Women in Engineering Program is an example of just the opposite situation. The federal government will quickly get back the entire $64,531 investment in increased federal income taxes.

The following analysis is based on a sample of twelve participants who had accepted engineering jobs by July 9, 1978, and on whom complete salary data was available. The analysis ignores the (1) twelve women who did not complete the program, (2) women who choses not to work or to continue in non-engineering jobs, and (3) the women who were still seeking engineering positions and who within several months will also be employed as engineers. In other words, the analysis is a very conservative estimate of the speed with which the federal government will recoup its total investment.

1. Cost of Program $64,531
   (NSF Grant)

2. Effect on Income of Sample Group (N = 12)

   A. Pre-Project Individual Income
      Average = $9,191/year
      N = 12
      Range = $0 to $19,650
      Total income for sample = $110,300

   B. Post-Project Individual Income
      Average = $18,740/year
      N = 12
      Range = $15,600 to $23,000
      Total income for sample = $224,880

C. Changes in Individual Income

Average difference = $9,548/year

N = 12

Range of differences = -$1,050 to $18,600

Total difference in income for sample = $114,580

Per cent increase in income for sample = 103.9%

3. Tax Benefits to Federal Government

A. Preprogram federal tax on sample group's income:

$\text{Total Income}_1 \times \text{Tax Rate}_1 = \text{Tax Paid}_1$

$\$110,300 \times (12\%) = \$13,236$

B. Post-program federal tax:

$\text{Total Income}_2 \times \text{Tax Rate}_2 = \text{Tax Paid}_2$

$\$224,880 \times (20\%) = \$44,976$

C. Increase in taxes paid:

$\text{Tax}_2 - \text{Tax}_1 = \text{Tax}$

$\$44,976 - \$13,236 = \$31,740$

4. Re-payment Period

$$\frac{\text{Investment}}{\text{Increased Taxes}} = \text{Repayment period}$$

$$\frac{\$64,531}{\$31,740/\text{year}} = 2.03 \text{ years}$$

Even if none of the other 28 participants ever increase their incomes as a result of the Women in Engineering program, the federal government will get back its entire $64,531 investment in about two years and after that it will earn dividend on its investment over the remaining thirty years of working life remaining for these twelve

women. Since many of the remaining twenty-eight participants will substantially increase their incomes as a direct result of the program, the pay-off to the federal government is even more impressive.

VII. CONTINUATION PLANS

The National Science Foundation has provided support for the Women in Engineering Program to be conducted for a second time during the period July 1978 through June 1979. Once that period is over, the program is likely to be able to continue on a self-supporting basis, although such a change in funding would alter the nature of the participant group because of necessary modifications in program format.

If the program were to be self-supporting, the University Extension would continue to promote, recruit, counsel, select and provide a summer refresher program for candidates as in the present program. University Extension would also coordinate co-op job placement, operate student support services (such as monthly meetings, career counseling, and employer fairs), publish placement brochures and facilitate student placement as in the NSF sponsored programs.

Students would take coursework comparable to that in the present program from local institutions. These courses are taught at most of the twenty-two institutions of higher learning located in the geographic areas of current participants. Courses would be taken in accredited departments, but University Extension would be responsible for doing academic advising and channeling students to classes at suitable locations.

The final summer session of the current program would be made optional. This portion of the program was designed to make the students more attractive to the growing microprocessor industry in the San Francisco Bay Region. As the identity of the program grows, this course may not be necessary for most students. For those students who might otherwise have difficulty with placement this course would be an option available to them at an extra cost.

The cost of University Extension's operation within the framework of this proposed change is estimated to be approximately $30,000, not including the optional second summer session. This cost does not include University "in-kind" services which include partial support of Extension staff engaged in this project. "In-kind" services are estimated to be $17,155. The direct cost of $30,000 would have to be distributed among the participants. If no

other support were obtained from industry or extramural agencies, the program cost would be $750 per student based on an enrollment of forty students. However funds would be solicited from other sources. It is hoped that the student fee for this program would not exceed $500, but to keep the cost to this level, donations and grants totalling approximately $10,000 would be necessary.

The lower division courses in this program (Circuits, Statics, and Properties of Materials) are available to students at local community colleges without charge. The upper division courses (Electronic Circuits, Linear Systems Analysis, and Computer Structures and Microcomputers) would be available at state colleges and universities at a total cost of approximately $265.

Total cost to the participant with only minimal extramural funding (approximately $10,000) would be $500 for University Extension, $200 for other tuition costs, $250 for room and board and $265 for books and supplies. Total cost per participant would be $1,215 compared to the present total of $765.

In addition to the increased cost to the participants, the self-supporting format would mean that students would most likely have to take classes during the day and on weekdays, as opposed to weekends. Such a format would make it extremely difficult for women to continue with full-time employment or take advantage of co-op jobs. Since they would be taking classes at local universities which operate on the semester or quarter basis, it would take participants <u>at least</u> an extra six months to complete the same courses. Many of the current participants have indicated that they could not or would not have joined the program without its condensed, weekend format.

VIII. CONCLUDING REMARKS

The U.C. Davis NSF Women in Engineering Program set out to provide a year of instruction in electrical engineering, offered in a unique format, and leading to participants' being hired into positions equivalent to those attained by current B.S. graduates in engineering.

The experience at Davis has shown that such a program is feasible and attractive to relatively large numbers of re-entry women. Their success in obtaining engineering jobs at above average salaries demonstrates that an intensive program of this nature can make re-entry students competitive with current engineering graduates.

The format of summer sessions before and after 10 months of weekend classes proved a viable way of offering an educational opportunity to women who need to work full-time while going to school. The same format could easily be used to teach many other series of courses. The scheduling makes it possible to employ instructors who might otherwise not be willing or able to teach during the regular work week.

Not only did the NSF Women in Engineering Program achieve most of its original objectives, it did so in a very cost-efficient manner.